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Navigation Laws Suspended

In accordance with the provisions of the emergency measure enacted by Congress soon after the outbreak of the European war, admitting foreign built ships owned by American citizens or corporations to United States registry for foreign commerce, the President of the United States issued on September 4 an executive order providing that all foreign built ships admitted to American registry under the emergency act may retain the watch officers employed thereon for seven years from the date of this order, and that such watch officers shall be eligible for promotion. Any vacancy occurring among such watch officers within two years from the date of this order may be filled without regard to citizenship, but any vacancies which occur after the two-year limit shall be filled by a watch officer who is a citizen of the United States. The President also suspended for two years the provisions of law requiring survey, inspection and measurement by officers of the United States for foreign built ships admitted to United States registry under the emergency act.

Foreign Built Ships Registered

Up to September 20, twenty-four foreign built vessels, having an aggregate tonnage of 100,820 gross tons, had been transferred to American registry and preliminary papers were being prepared for the admittance of twenty-seven other vessels of 106,360 gross tons. The first corporations to take advantage of the emergency measure were the United Fruit Company of Boston, which is placing twenty-five of its vessels, aggregating 117,000 gross tons, under the American flag, and the United States Steel Products Company, which is the export subsidiary of the United States Steel Corporation, which has applied for American registry for nine of its steamships. This emergency act has imposed no hardships upon the American shipbuilding industry nor upon American shipowners. On the other hand, it has eased the situation for American owners who have been operating vessels in the foreign trade under foreign flags, and especially for those whose ships were flying the flag of a belligerent nation. But as a means of providing for a permanent expansion of the American foreign merchant marine, it cannot be looked upon with favor. With the amount of idle tonnage available on account of the rapid falling off of foreign commerce, some more definite policy based upon the conditions which are likely to prevail after the war is over will be required before new steamship companies can enter the field and assume the burdens of American registry with confidence of success in competition with foreign shipowners.

Geared Turbines

Innovations in marine machinery are usually met with a cold shoulder, until after several years of service they have proved conclusively that the claims made for them are well founded. Mechanical gearing for marine turbine machinery for the propulsion of ships is no exception. The theoretical advantages of this system of propulsion are obvious. The characteristics of the turbine and the propeller are well known. One is more efficient at high speeds, the other at low speeds, and the compromises that have necessarily been made in adapting one to the other for direct turbine drive have seriously militated against the application of the turbine to certain classes of vessels. As an alternative the introduction of mechanical gearing would appear to be ideal, provided its construction can be accomplished in such a manner as to insure a high efficiency of transmission and unquestionable durability under the trying conditions of service on board ship. How successfully mechanical reduction gearing has been developed for marine work can be seen from the installations recorded elsewhere in this issue, and the possibilities of its future application are strikingly illustrated.

Security of Marine Mortgages

An unnecessary hindrance to the upbuilding of the American merchant marine exists in the lack of protection afforded by the United States laws to bonds or mortgages on American vessels engaged in foreign trade. Recently one of the shipyards on the Atlantic coast was given an opportunity to build half a dozen large freight steamships for use in foreign trade, under the condition, however, that bonds on the ships be taken over by the shipbuilding company. After consultation with bankers in Boston, New York, Philadelphia and Baltimore, representatives of the shipbuilding company found that it would be impossible to secure financial support for this enterprise for the reason that the laws of the

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United States do not protect such securities. As a matter of fact, it would be possible for the owner of a vessel, bonded in this manner, to take the ship beyond the three-mile limit outside the coast of the United States to a foreign port, sell the ship and withhold the money represented by the bond issue, without being held liable for this amount by the United States laws. Such conditions militate against the upbuilding of the American foreign merchant marine, although the difficulty might easily be overcome by the enactment of a law providing that no American ship shall be sold or transferred in whole or in part to a subject or citizen of a foreign nation so long as there exists against the vessel any mortgage or lien, and that in the event of any such sale the vessel should be forfeited to the United States, without prejudice, however, to any mortgage or lien which might exist against the vessel. The enactment of such a law would be a simple matter of protection to the floating property of American citizens, and in view of the present increase of the American foreign merchant marine this matter should receive immediate attention by Congress.

State Control of Ports and Waterfronts

At the third annual convention of the National Association of Port Authorities, held in Baltimore September 8-10, at which practically all of the important ports in the United States, including those on the Great Lakes, were represented, some interesting papers on various phases of port construction, finance and administration were read. Among them was one by Mr. B. F. Cresson, Jr., chief engineer of the New Jersey Harbor Commission, on the subject of State control over ports and waterfronts, with special reference to public control, ownership and operation. At the last convention of this association the consensus of opinion appeared to be in favor of some form of public control over ports, waterfronts and terminal facilities, and experience in localities where this has been in practice seems to emphasize its correctness. Private ownership and control in many of the larger European ports have given way to public ownership and control, and in some cases public operation of port facilities has been successfully conducted.

Mr. Cresson pointed out that there is no question about the success of the ports of Montreal, New Orleans and San Francisco, which are not only under a large degree of public control and ownership, but also under a considerable degree of public operation. At the ports of Boston, New York, Philadelphia and Baltimore on the Atlantic coast, and at Los Angeles, Seattle and Portland on the Pacific coast, as well as at certain other ports, public ownership has, to some extent, been practiced, although public operation of port facilities has not been attempted to any great extent.

Transportation companies which own and operate waterfront terminals are themselves under a large degree of public control. The Interstate Commerce Commission and the various State commissions exercise control over private transportation rates and services, and this extends over the terminal facilities privately owned and operated on the waterfront. In fact, there is scarcely any business, corporation, or industry or any public utility that may be said to be free from a certain degree of public control. As practically the only chance for a transportation company to create a monopoly in water transportation is by monopolizing the waterfront at terminal points, the public has a decided interest in the ownership, layout, use and operation of the waterfront at points where the transfers of commodities between land and water carriers can advantageously be made.

Decline in Foreign Commerce

An indication of the extent to which foreign commerce was affected during the first month of the war is shown by the reports published by the Bureau of Statistics at Washington for the imports and exports of the United States for the month of August. The August exports of merchandise amounted to less than 72 percent of the exports in July and were only 59 percent of the exports in August last year. No single month since the summer of 1909 has showed such a small total of merchandise exports for the United States. The items which showed the greatest decline were cotton, mineral oils and meat products; breadstuffs showed a slight increase.

Imports showed a smaller decline than exports. The imports for August amounted to 81 percent of the imports in July and 94 percent of the imports in August a year ago. Of the imports, 61.8 percent entered free of duty, as compared with 50.9 percent in August, 1913, and 54.3 percent in August, 1912. The greater loss in exports was due probably to the fact that many of the ships with cargoes for this country were on the high seas at the time war broke out, and therefore reached this country in August, while the blockade of foreign trade was felt in the export trade as soon as war was declared.

In England, according to the British Board of Trade reports, both imports and exports declined rapidly in August. The month's imports were 24 percent less than a year ago and the exports 45 percent less. Two-thirds of the decline was evidently due to the stoppage of trade with the Continent, the principal item being manufactured products. The supply of raw materials was also cut down materially, although slight increases were shown in raw cotton and metallic ores other than iron. There were also satisfactory increases in the imports of grain and flour.

Along with the decline in foreign commerce, the shipbuilding industry in England has suffered to a considerable extent. On the Clyde, for instance, the output from the shipyards in August was the lowest for the month since 1886. The disturbed state of shipping, due to heavy war risks, has, of course, greatly retarded the production of new vessels, and added to this is the fact that recently work has been concentrated on naval vessels.

How greatly the foreign commerce of the world can

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be deranged by war in Europe is shown by the fact that the United States, the United Kingdom, Germany, France and the Netherlands each offer a market for over a billion dollars' worth of foreign products. Great Britain buys $3,000,000,000 (£615,000,000) worth of foreign products, about 20 percent of which is from the United States; Germany, $2,500,000,000 (£513,000,000), with 15 percent from the United States; France, $1,500,000,000 (£308,000,000), of which 11 percent is from the United States, and the Netherlands, which is an important center for the transshipment of foreign goods, nearly $1,500,000,000 (£308,000,000), in which American goods figure to the extent of about 10 percent. Manufactures form 80 percent of the exports from the United Kingdom, 76 percent of the exports from Switzerland, 65 percent of the exports from Germany, 58 percent of the exports from France, and 47 percent of the exports from Austro-Hungary, while Canada, Central and South America, Australia, New Zealand and South Africa, all of which are important markets for manufactures, send large quantities of foodstuffs and raw materials to Europe in exchange for manufactured products. With war in progress in Europe it is evident that new sources of supply must be found, even though the demand for manufactured products is temporarily lessened.

Naval Losses

Notwithstanding the widely divergent views of extremists, which are always heard when the relative values of different modes of modern naval warfare are discussed, the advocates of the submarine are finding much to support their opinions in the relatively few encounters that have taken place since the European war began. Although only minor naval engagements have so far taken place and the reports of these are fragmentary and by no means complete, nevertheless the character of the encounters would indicate that submarine warfare is bound to be an important factor in future naval conflicts. The torpedo has become a far more accurate and effective weapon than it was ten years ago; the range and speed of the submarine boat have greatly increased, and in the meantime means for protecting the ordinary surface warship from under-water attack have advanced but little, if at all, although the subject has received more careful consideration of late.

Up to the time of writing, about two-thirds of the British naval losses have been due either to mines or to submarine attack, and the German naval forces have suffered somewhat from the same source. Up to September 23, Great Britain had lost three armored cruisers, three light cruisers and one torpedo boat; Germany had lost five light cruisers, three destroyers, a submarine and two converted merchant vessels, and Austria had lost three cruisers and two torpedo boat destroyers. The most important engagement took place in the Bight of Helgoland on August 28, when a strong force of British destroyers, headed by the light armored cruiser *Arethusa*, a new vessel which had been in commission only a few days, decoyed several German light cruisers and destroyers out into the open sea, and with the aid of a formidable squadron of battle cruisers, succeeded in sinking the light German cruisers *Mainz* and *Ariadne*, the *Köln* and two destroyers. A later and more disastrous engagement took place in the North Sea on September 22, when a single German submarine sank the British armored cruisers *Cressy*, *Hogue* and *Aboukir*, sister ships commissioned in 1899 and 1900.

Three of the other British losses were due to the explosion of mines. The light cruiser *Amphion* was sunk by a mine off the coast of Holland after destroying the German mine layer *Königin Luise*. The torpedo gunboat *Speedy* and the scout cruiser *Pathfinder* were also destroyed by mines in the North Sea early in September. The British cruiser *Warrior* went aground near the Bosporus on September 7, while the cruiser *Pegasus* was disabled by the German cruiser *Königsberg* in the harbor of Zanzibar on September 20.

The German losses, in addition to those in the battle off Helgoland, include the cruiser *Panther*, reported sunk near Bona, Algeria, by French cruisers; the cruiser *Augsberg*, sunk by a Russian torpedo boat in the Baltic Sea; the submarine *U* 15 sunk in the North Sea by the British cruiser *Birmingham;* the light cruiser *Magdeburg*, which went aground in a storm on the island of Oldensholm, at the entrance to the Gulf of Finland, and was destroyed by Russian warships; the destroyer *S* 90, sunk off the Chinese coast by the British destroyer *Welland*, and the light cruiser *Hela*, which was sunk by a British submarine off Wilhelmshaven.

The French navy, while suffering no losses herself, has succeeded in sinking three of the Austrian cruisers, two off Budua, Dalmatia, and one in the Adriatic, while two Austrian warships have been destroyed by mines.

Of the converted merchant vessels which have been in actual conflict Germany has lost the *Königin Luise*, mentioned above, the former North German Lloyd liner *Kaiser Wilhelm de Grosse*, which was sunk by the British cruiser *Highflyer* off the west coast of Africa on August 27, and the *Cap Trafalgar*, which was sunk in an encounter with the British converted merchant ship *Carmania* off the east coast of South America on September 14. The only armed merchantman lost by Great Britain was the *Oceanic*, formerly of the White Star Line, which went ashore on the north coast of Scotland September 9 and became a total wreck.

That light-armored cruisers and armed merchantmen, which must depend upon their speed for protection, should fall an easy prey to armored warships is to be expected. Such vessels have little value as fighting units in a naval engagement and are useful mainly as scouts and commerce destroyers. But that armored warships are equally defenseless against under-water attack, as has been indicated by the early naval losses in the present war, tends to lessen the reliance that has hitherto been placed upon superior gun power as a measure of naval strength.

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Geared Turbines for Propelling Vessels

Some Interesting Features of Their Application to the Largest Express Liner—Possible Savings

BY W. W. SMITH

The application of steam turbines to the propulsion of vessels has been exceptionally rapid and successful in spite of the inherent limitations of speed where the turbine is connected directly to the propeller. This is striking evidence of the excellence and desirability of this type of propelling machinery. As is generally well understood, the turbine demands a high speed, whereas the propeller must run at a low speed to attain the best individual and combined efficiencies.

The solution of the marine turbine problem which makes possible all of the natural advantages of the turbine which result from a high rotative speed is the reduction gear. Since the construction and test of a 6,000 horsepower experimental gear by the Westinghouse Machine Company, of East Pittsburgh, Pa., in 1909, which proved the possibility of transmitting large powers through high speed helical spur gears, geared turbines have been used in a number of installations both on land and sea. It is interesting to note that the Westinghouse Company alone has 95,000 horsepower of large reduction gears in service and building for land and marine installations; while abroad, where marine engineering is less conservative, there is about 500,000 horsepower of marine geared turbines built and building.

An examination of the results which have been obtained with geared turbines will be sufficient to convince the most conservative that the next step in the rapid progress in propelling vessels will be the geared turbine. The engineering and commercial advantages are so great that they demand the closest attention. Shipowners and marine engineers cannot afford to ignore such great advantages, which, within a short time, may spell success or ruin in the keen competition of the future.

The advantages of geared turbines can best be illustrated by specific comparison, and for this purpose it will be of especial interest to select the largest and most powerful transatlantic express steamer, because it embodies the very highest engineering skill and achievement. So to speak, it is the last word in marine engineering. The great improvement which may be obtained by the use of geared turbines is most striking. Therefore in the contest for supremacy in speed and power, the next step seems obvious.

Hence, because she is the latest, largest and most powerful steamship afloat, the giant Hamburg-American steamer *Vaterland* will be used for this illustration. It hardly seems possible that much improvement could be made in this extraordinary vessel, yet, as shown herein, her speed could be increased by about two knots by the use of geared turbines.

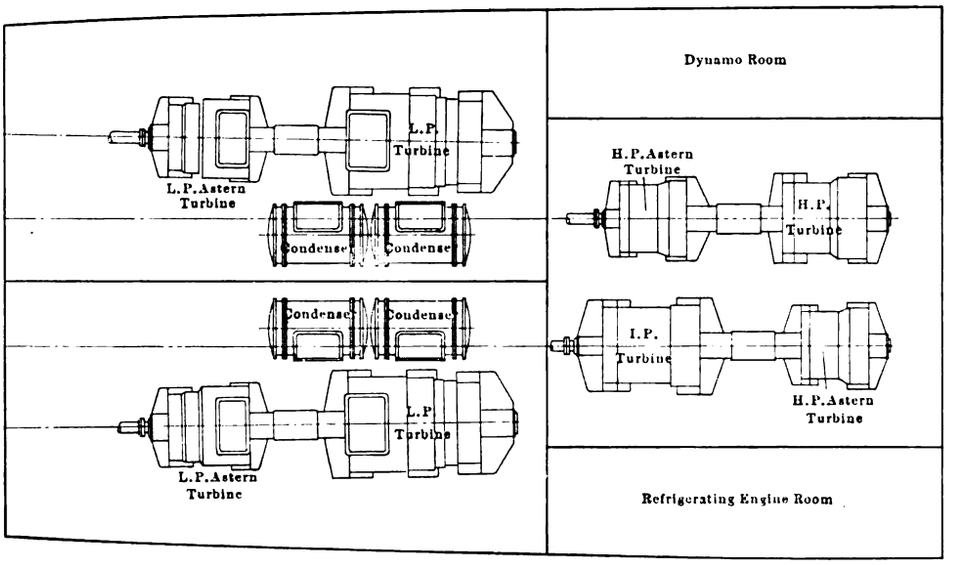

Fig. 1.—Engine Room of S. S. *Vaterland*. Present Arrangement with Direct Turbine Drive

Geared Turbines Applied to the Vaterland

Before proceeding, it should be understood that this paper is not intended as a criticism in any sense. In fact, the engineers and builders of the *Vaterland* deserve the highest commendation for producing this peerless vessel. It is merely intended to point out the great natural advantages of geared over direct drive turbines.

As shown in Fig. 1, the present machinery of the *Vaterland* consists of a high-, an intermediate- and two low-pressure turbines for going ahead, and two high-pressure and two low-pressure astern turbines. The turbines drive four propellers, to which they are directly connected, at 170 revolutions per minute. The proposed geared turbine machinery consists of four geared turbine units, driving the propellers at 130 revolutions per minute. Each unit consists of a two-pinion reduction gear driven by a high- and low-pressure turbine, the latter containing the reversing turbine. A Kingsbury segmental thrust bearing is included in the unit, so that the space

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which would otherwise be required for a large collar type thrust bearing is saved. A further saving in space is effected by locating the condenser under the turbines, which is made possible by the reduced size of the turbines and the flexibility of design permitted by the reduction gear.

The propellers of the *Vaterland* have a speed of 170 revolutions per minute. Even this comparatively low speed is too high for the best propeller efficiency. It is hardly probable that it exceeds 60 percent, and with this efficiency the shaft horsepower required for the effective propelling power of 43,200 would be 72,000. To attain the highest propulsive efficiency for this vessel, the propeller speed should be about 130 revolutions per minute, which, for this reason, is the speed selected for geared turbines. At this lower speed of revolution there should be no difficulty in obtaining an efficiency of 65 percent. In fact, it has been done in a number of recent vessels. With this improved efficiency, the shaft horsepower required for the same effective power would be 66,500—a saving of 5,500 horsepower, or 7½ percent.

While the saving due to improved propeller efficiency is large, it is considerably less than that due to improved turbine economy. With the turbine and propeller direct connected so that both revolve at the same speed, not only is it necessary to sacrifice the efficiency of the propeller, but the efficiency of the turbine as well.

For equal efficiencies in any two turbines, the number of rows of blades is, roughly speaking, inversely proportional to the squares of the respective peripheral speeds of the rotating elements. The peripheral speed of the rotating elements in the turbines of the *Vaterland* is only one-third of the speed common in large turbines used on land. This would mean, to obtain the efficiencies common to the latter, the former would require approximately nine times as many rows of blades, which would make a machine of prohibitive length. To maintain the same speed of revolution and increase the peripheral speed of the turbines of these vessels to the point common in land practice, the rotors would have to be nearly 40 feet in diameter, which is manifestly beyond the shadow of possibility.

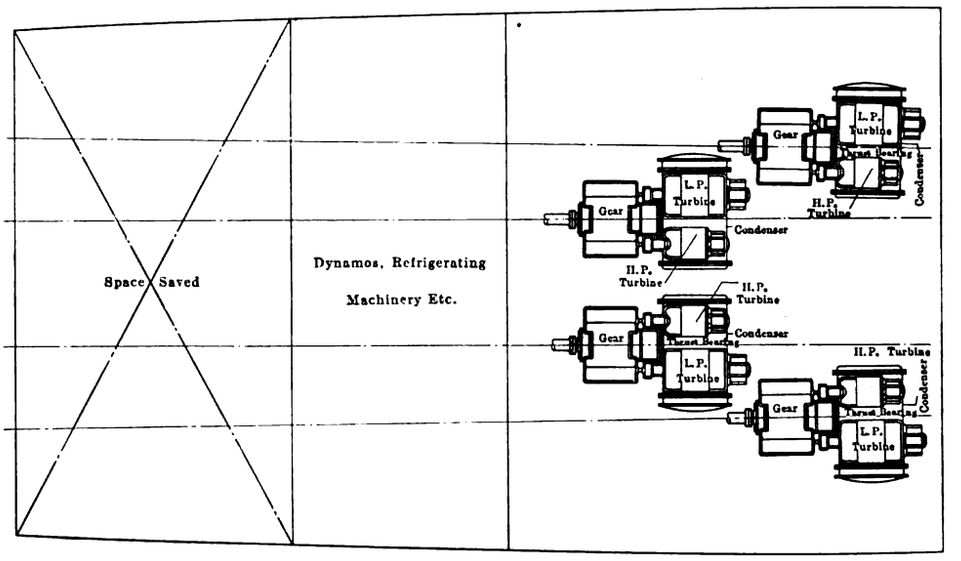

Fig. 2.—Engine Room of S. S. *Vaterland*. Suggested Arrangement with Geared Turbines. Floor Space Saved in Engine Room About 30 Percent

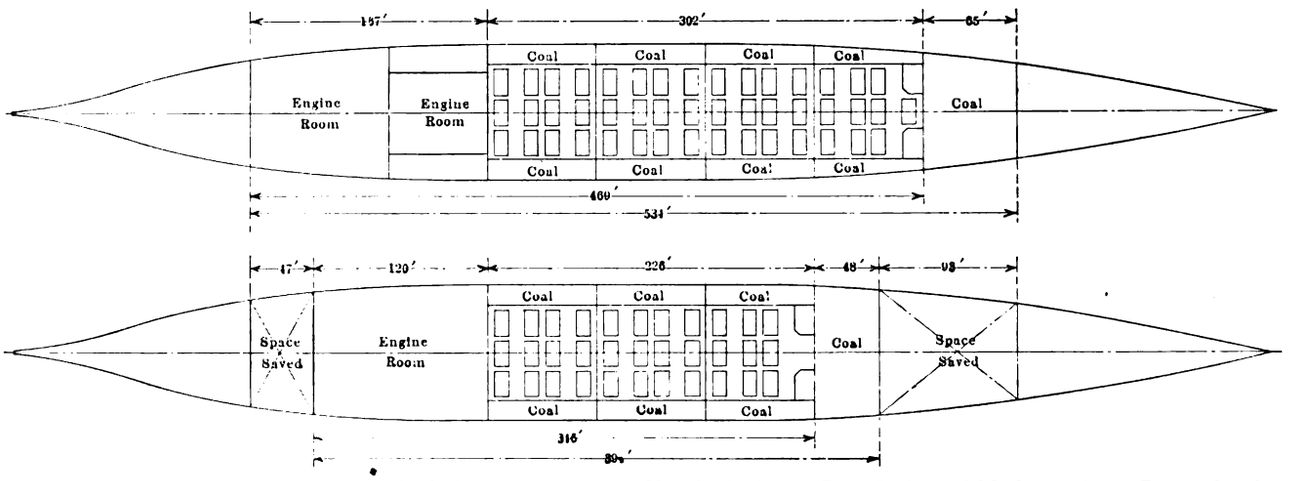

Fig. 3.—Upper Plan, Present Boiler and Machinery Space S. S. *Vaterland*. Lower Plan, Boiler and Machinery Space Required with Geared Turbine Machinery. The Saving in Boiler Capacity and Space Due to Use of Geared Turbines Is More Than One-Fourth

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The speed of the present turbines is 170 revolutions per minute, whereas the speed (mean) of the geared turbines is 1,725 revolutions per minute, or about ten

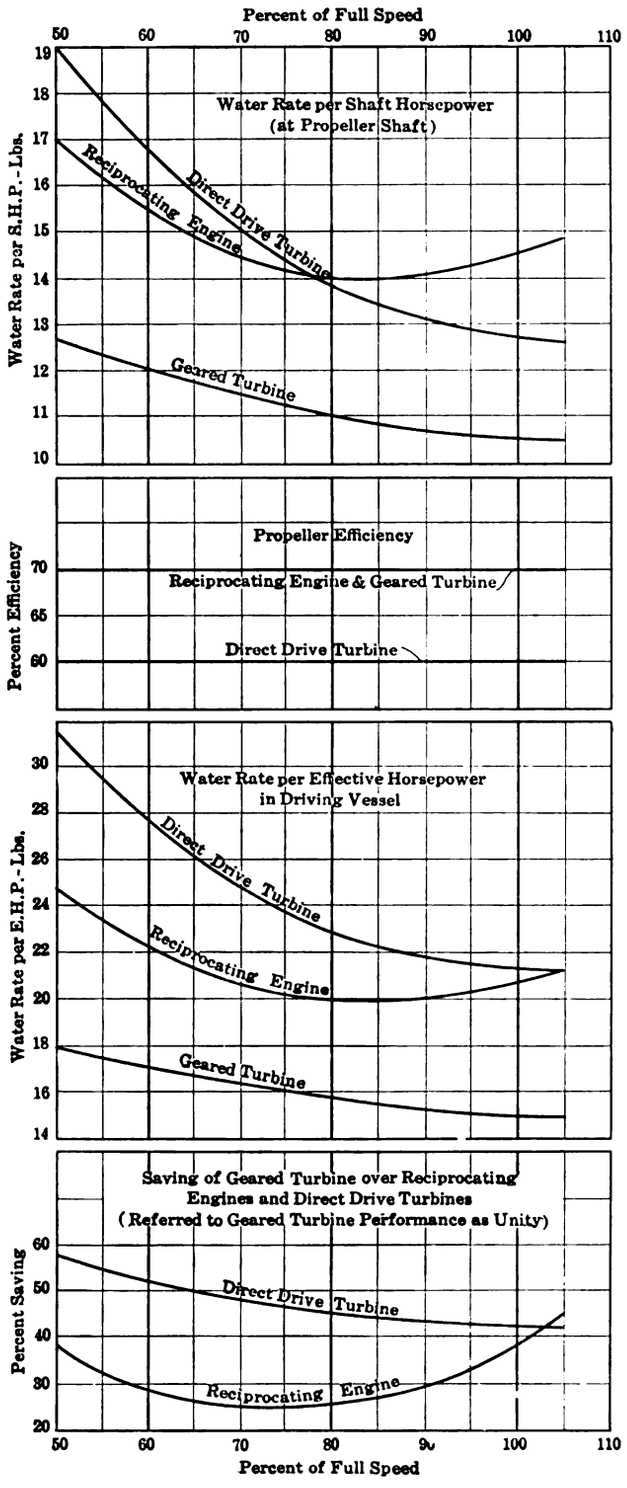
Percent of Full Speed
50 60 70 80 90 100 110
Water Rate per Shaft Horsepower (at Propeller Shaft)
Water Rate per S.H.P.-Lbs.
Reciprocating Engine
Direct Drive Turbine
Geared Turbine
Propeller Efficiency
Percent Efficiency
Reciprocating Engine & Geared Turbine
Direct Drive Turbine
Water Rate per Effective Horsepower in Driving Vessel
Water Rate per E.H.P.-Lbs.
Direct Drive Turbine
Reciprocating Engine
Geared Turbine
Saving of Geared Turbine over Reciprocating Engines and Direct Drive Turbines (Referred to Geared Turbine Performance as Unity)
Percent Saving
Direct Drive Turbine
Reciprocating Engine
Percent of Full Speed

Fig. 4.—Comparison Between the Performances of Reciprocating Engines, Direct Drive and Geared Turbines for a Battleship of 21 Knots and 28,000 Shaft Horsepower, Based on Trial Data of Recent Battleships. (Steam Pressure, 250 Pounds; Vacuum, 28½ Inches)

times as great. From the best information obtainable, it is believed that the steam consumption of the *Vaterland's* turbines cannot be less than 11.8 pounds per shaft horsepower per hour, while it has been demonstrated beyond question that in turbines of the same capacity operating at speeds which the reduction gear makes possible for marine service, the steam consumption will not exceed 9.0 pounds per shaft horsepower per hour, a saving of 24 percent. This saving, together with that due to the improved propeller efficiency, makes a total reduction in steam consumption of 30 percent for the turbines only, and 28 percent for all machinery. (See table.)

Geared Turbines Applied to Lusitania

As the machinery of the *Lusitania* resembles very closely that of the *Vaterland,* it will be of interest to note the actual results obtained in service. The following data were obtained from a paper by Mr. Thomas Bell, read before the Institution of Naval Architects, April 9, 1908, and published in International Marine Engineering, August, 1908:

Speed in knots	25.4
Revolutions per minute	190
Effective horsepower	33,000
Shaft horsepower	68,850
Propulsive efficiency—E. H. P./S. H. P.	48 percent
Steam consumption, in pounds, per shaft horsepower-hour of main turbines:	
For turbines only	12.77 pounds
For auxiliaries	1.69 pounds
For all machinery	14.46 pounds
Steam consumption per effective horsepower-hour:	
For turbines only	26.6
For all machinery	30.0
Coal consumption, in pounds, per shaft horsepower-hour	1.43
Coal consumption per day	1,050 tons
Coal consumption per voyage of 3,100 nautical miles	5,390 tons
Actual evaporation of boilers, pounds of steam per pound of coal.	10.1
Steam pressure, pounds, gage at turbine	145
Vacuum in inches of mercury referred to 30-inch barometer	28
Feed-water temperature, degrees F.	165

Geared turbines in the *Lusitania* would effect even a larger saving than in the *Vaterland.* Under the above conditions, geared turbine machinery should give a steam consumption of 10.0 pounds per shaft horsepower and a propeller efficiency above 60 without difficulty. This represents a water rate per effective horsepower of less than 16.7 pounds, and a saving over the above performance of over 9.9 pounds, or 37 percent.

Possible Savings

The effect of reducing the steam consumption by one-fourth is far-reaching. Primarily, it means that only three-fourths of the present boiler power is required, or that 13 of the 46 boilers could be omitted. And, furthermore, there is a corresponding reduction in condensers and auxiliaries. The total reduction in weight of machinery would be about 40 percent, or about 3,000 tons, which would represent a saving of about $700,000 (£143,000) in the first cost of the machinery installation.

Due to the reduction in the weight of machinery and coal, and the space required therefor, the cargo capacity would be increased by about 5,300 tons, which would represent an additional earning of about $600,000 (£123,000) per year. The maximum possible earning would be considerably more, or over $1,500,000 (£308,000).

The coal consumption would be reduced more than one-fourth, or about 330 tons per day. With coal at $3.25 (13/6½) per ton, the saving per voyage would be $6,700 (£1,370), and per year about $162,000 (£33,200).

Due to the reduction in the boiler power and coal consumption, the number of the fire room force would be reduced about one-fourth, resulting in a saving in wages and subsistence which would further reduce the operating expenses by about $31,300 (£6,420) per year.

Due to the smaller machinery installation, and its less first cost, the interest, insurance, depreciation, repairs, etc., would be reduced proportionately, or by about $105,000 (£21,500) per year.

Thus it is seen that the total saving per year would be

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about $898,000 (£184,000), which, when capitalized at 6 percent, would represent a value of $15,000,000 (£3,080,000). Hence from a financial viewpoint, it is obvious that geared turbines are a most profitable investment. In fact, when this saving is based on the cost of the geared turbines alone, the interest rate which they would pay on the investment would be about 300 percent, or they would pay for themselves in about four months.

If greater speed would be regarded as more attractive than the possible economies mentioned above, it is easy to see that with the present boiler capacity and with the same coal consumption, geared turbines would develop about one-fourth more power, making a total of 90,000 shaft horsepower, which would increase the speed by about two knots, or from 23.5 to 25.5 knots, and reduce the time of passage (from Hamburg to New York) by 12 hours. Thus the *Vaterland* would be not only the largest, but also one of the fastest express steamers.

Of course, the *Vaterland* can at present make more than 23½ knots by forcing, and likewise with geared turbines the speed could be increased according to steam supplied. For the above comparison, the normal full speed conditions were selected for obvious reasons.

If, instead of the above, it were considered desirable to keep the same speed and cargo capacity, but to obtain the benefits of geared turbines by reducing the weight of machinery and hull, and, as a result, the displacement and effective horsepower, the advantages in favor of geared turbines would be found to be substantially the same. In fact, this is only another way of expressing the same comparison. The saving in a vessel of such large power is naturally very great, and while the actual saving which could be effected in smaller vessels is relatively smaller, the percentage of saving is about the same and of no less importance to the owner.

The saving in space which can be effected by the use of geared turbines is shown in Figs. 2 and 3. In addition to the higher efficiency of the geared turbines which results from their higher speed, they are very much smaller, which greatly simplifies their construction and operation. The weight of geared turbines, including the gears, is about one-fourth of that of the large slow-running machines. As the units and parts to be handled are much smaller, the facilities for the inspection and repairs of geared turbines are better. For example, the weight of the largest rotor, the low-pressure, of the *Vaterland* is 135 tons, whereas the largest rotor of the geared turbines would weigh but 11 tons, and could therefore be handled with comparative ease. The total length of blading is reduced from about 122 miles in the direct-drive to about 12 miles in the geared turbines—a reduction of over 90 percent.

In the Westinghouse turbine, the steam is expanded to a considerable volume in nozzles, and the energy due to this expansion is absorbed in an impulse wheel having two rows of moving blades. When superheated steam of high-pressure is used, it is confined in the nozzles, where it is expanded and very much reduced in pressure and temperature, so that the casing of the turbine is never exposed to the high-pressures and temperatures which cause distortion, resulting frequently in blade troubles. As a considerable portion of the total energy in the steam is given up in the impulse wheel, there is considerable reduction in the length of the rotor, giving a short, stiff rotor, which effectually prevents vibration.

An important advantage of the compact and substantial construction of geared turbines is that they can with perfect safety be started cold and brought up to the full speed at once. In naval vessels particularly this is a matter which is often of the highest importance. With turbines directly connected to the propeller shafts, the lengths and diameters of the rotors and casings are such that in order to prevent distortion from unequal heating and expansion, it has been found necessary in practice to bring all of the turbine machinery to the normal working temperature as nearly as possible before it may safely be set in motion. In large vessels this warming process requires several hours. The smaller dimensions resulting from the higher speed of geared turbines give a sturdier construction in which the tendency to distortion is reduced to a negligible minimum. In case of emergency, the steam, even though it carries with it considerable water

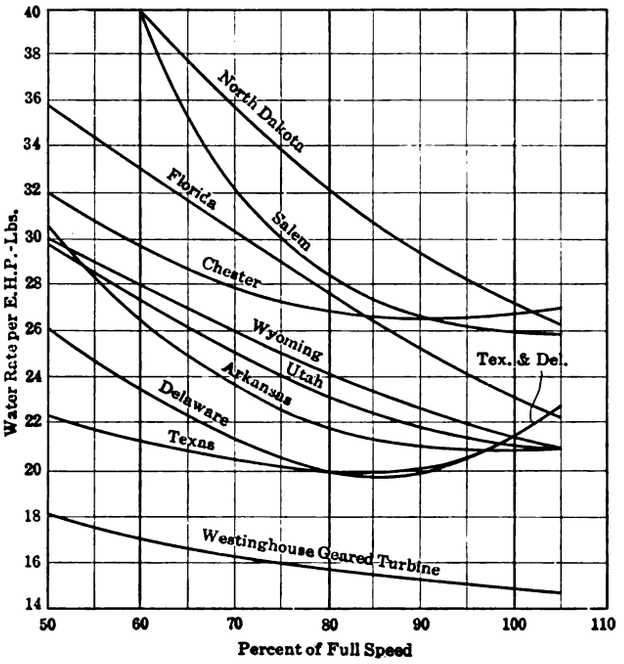

Fig. 5.—Comparison Between Water Rates per Effective Horsepower of U. S. Battleships and Westinghouse Geared Turbines Operating Under Same Conditions. Data from Official Trials (Turbines Only; Auxiliaries not Included)

of condensation, may be admitted to cold turbines, and the full speed attained in about a minute.

By locating the condenser under the turbine, which is made possible by the use of geared turbines, an exceedingly compact unit is obtained. As the steam passes directly into the condenser, the exhaust pipe and the consequent drop in pressure are eliminated. As the turbine drains by gravity, water cannot accumulate, and hence this cause of stripping the blading and of corrosion is eliminated.

Loss of Power in Reduction Gears

The highly economic performance of geared turbines is only made possible by the exceedingly small loss in transmission through the reduction gear. It has been found from tests that the loss is between one and one and one-half percent. This means that the loss in each reduction gear proposed for a vessel similar to the *Vaterland* would be about 200 horsepower, or less than 1,000 horsepower for all four gears.

As the superiority of the helical reduction gear to other methods of speed reduction lies principally in its greatly superior efficiency, it will be of interest to compare the losses in the various systems. From the best information available, it is believed that the losses in the

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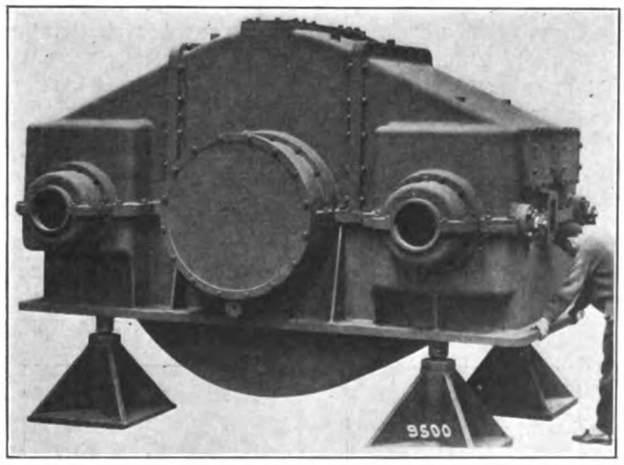

Fig. 6.—Reduction Gear for U. S. S. *Melville* Erected in Builders' Shop. Revolutions per Minute, 1,400 to 110; Shaft Horsepower, 4,000; Diameter of Gear, 95 Inches; Diameter of Pinions, 7½ Inches; Weight, 64,000 Pounds

electric and hydraulic systems of speed reduction cannot be less than 8 percent and 10 percent respectively. Hence the loss of power with electric drive would be 5,600 horsepower, and with the hydraulic 7,200 horsepower, as compared with 800 for the helical gear. The saving of five or six thousand horsepower is of importance, not only because it represents considerable reduction in the cost of operation, but also, as should be clear from the above, because of the reduction in boiler capacity, auxiliaries, etc., in consequence thereof.

The mechanical operation of the gear is not a matter of speculation. The ability of the reduction gear to transmit large powers safely and efficiently has been conclusively demonstrated on land and sea by over 70 gears built by the Westinghouse Company. These gears have proved entirely reliable under varied and severe operating conditions. Most of them are used for large direct current generators and operate under considerably more severe conditions than those on board ship. In many cases the units have been kept in practically continuous service for months, and subjected to frequent short circuits which instantly increase the load to several times the normal full load, thereby imposing shocks and strains on the gear much more severe than ever experienced in marine service. They have operated successfully under the existing service conditions, which in many cases were unfavorable, and where they have received but little attention. It has been found that there is no vibration and that the operation of the gears is very quiet, the noise being negligible. In every case the teeth have taken a brilliant mirror-like polish, which forms a dense,

COMPARISON BETWEEN GEARED AND DIRECT-DRIVE TURBINES FOR EXPRESS STEAMER VATERLAND

	Direct-Drive Turbines	Geared Turbines	Actual Saving	Percent Saved
1. R.P.M. of propellers for 23½ knots	170	130		....
2. R.P.M. of turbines—H. P	170	1,800	.....	....
3. R.P.M. of turbines—L. P	170	1,650	.....	....
4. Number of reductions—H. P	.....	13.8	.....	....
5. Number of reductions—L. P	.....	12.7	.....	....
6. Propeller efficiency—percent	60	65	.....	....
7. Horsepower, effective for 23½ knots	43,200	43,200	.....	....
8. Horsepower, shaft for 23½ knots	72,000	66,500	5,500	7½
*9. Steam consumption per S.H.P. hr. lbs.—turbines	11.8	9.0	2.8	24
10. Steam consumption per S.H.P. hr. lbs.—auxiliaries	1.8	1.5	.....	....
11. Steam consumption per S.H.P. hr. lbs.—all purposes	13.6	10.5	.....	....
*12. Steam consumption per I.H.P. hr. lbs.—all purposes	12.5	9.65	.....	....
13. Steam consumption per E.H.P. hr. lbs.—turbines	19.7	13.8	5.9	30
14. Steam consumption per E.H.P. hr. lbs.—all purposes	22.7	16.2	6.5	28
*15. Coal consumption per S.H.P. hr. lbs	1.51	1.17	.....	....
16. Coal consumption per I.H.P. hr. lbs	1.39	1.08	.....	....
17. Coal consumption per day—tons	1,165	835	330	28
18. Coal consumption per voyage of 3,520 miles—tons	7,270	5,210	2,060	28
19. Coal consumption per year (24 voyages)—tons	174,600	125,000	49,600	28
20. Weight of main turbines (and gears)—tons	2,600	500	2,100	81
21. Weight of all other machinery—tons	4,500	3,600	900	20
22. Weight of all machinery—tons	7,100	4,100	3,000	42
23. Weight of coal required (bunker capacity)—tons	8,200	5,900	2,300	28
24. Weight of machinery and coal—tons	15,300	10,000	5,300	34½
25. Space, floor, occupied by turbines and gears—square feet	3,574	1,760	1,814	51
26. Space, floor, length for all machinery—feet	534	394	140	26
*27. Space, volume for all machinery—cubic feet	1,516,000	1,121,000	395,000	26
28. Turbines, weight of largest—tons	350	33.5	316	90
29. Turbines, weight of largest rotor—tons	135	11	124	92
30. Turbines, number of blades	750,000	160,000	590,000	79
31. Turbines, number of miles of blading	122	11.3	111	91
32. Boilers, number	46	33	13	28
33. Boilers, heating surface—square feet	203,000	146,000	57,000	28
34. Condensers, cooling surface—square feet	65,000	46,800	18,200	28
35. Fire room force, number of men	360	266	94	26
36. Cost of coal per day (at $3.25 per ton)—dollars	3,780	2,710	1,070	28
37. Cost of coal per voyage—dollars	23,600	16,900	6,700	28
38. Cost of coal per year—dollars	568,000	406,000	162,000	28
39. Cost of fire room force per day—dollars	331	245	86	26
40. Cost per fire room force per voyage—dollars	2,070	1,530	540	26
41. Cost of fire room force per year—dollars	119,000	87,700	31,300	26
42. Cost of machinery—dollars	1,900,000	1,200,000	700,000	37
43. Cost of interest, insurance, amortization, repairs and supplies—dollars	285,000	180,000	105,000	37
44. Earning due to 5,300 tons additional cargo capacity—dollars	.....	.....	600,000	....

*9. Steam pressure 235 pounds gage; vacuum, 28½ inches. *15. Evaporation, 9.0 pounds. *12. S.H.P.=I.H.P. × .92. *27. Below deck, 4.

SUMMARY OF SAVING (PER YEAR) DUE TO USE OF GEARED TURBINES.

Coal	$162,000.00	(£33,200)
Fire room force	31,300.00	(6,420)
Fixed charges, repairs and supplies	105,000.00	(21,500)
Additional earning due to enlarged cargo space	600,000.00	(123,000)
Total saving and increase in revenue	$898,300.00	(£184,000)
Total saving and increase in revenue, per S.H.P.	$12.50	(£2.6)

Capitalized value of total saving at 6 percent—$15,000,000 (£3,080,000).

NOTE.—The information for the above table was obtained from various sources and is the most reliable obtainable. While some of the values were assumed, it is believed that they agree very closely with the actual. However, it should be understood that the table is based on assumptions and that it is only intended to represent a close approximation.

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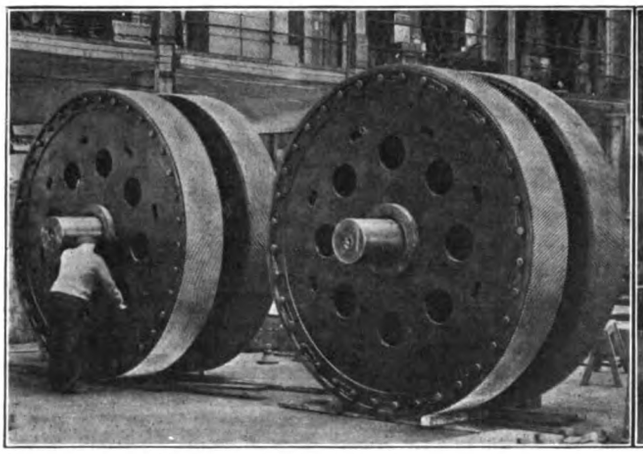

Fig. 7.—Gear Wheels for 35,000 Horsepower Reduction Gears. Diameter of Gears, 120 Inches; Diameter of Pinions, 7 Inches; Revolutions per Minute, 1,900 to 110

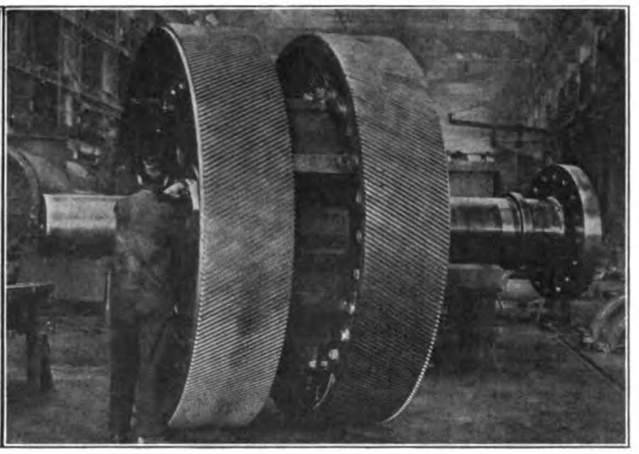

Fig. 8.—Gear Wheels for 6,000 Horsepower Reduction Gear. Revolutions per Minute, 1,800 to 180; Diameter, 100 inches. This Gear Has Been in Successful Operation for Over a Year and a Half

hard skin of exceeding durability on the working surfaces. The wear on the teeth is exceedingly small, and in many cases it has been impossible to detect by accurate measurement of the teeth any wear whatever in gears which have been in service for over two years. It has been demonstrated beyond question that the life of the gear is very long, and that it will exceed the life of the ship.

TRANSMISSION OF LARGE POWERS

The ability to transmit large powers has been conclusively demonstrated by the fact that the Westinghouse Company have built and operated with entire success the following large gears: Three of 6,000 horsepower, one of 4,000 horsepower, five of 3,500 horsepower, and seven of 2,000 horsepower. Four of the 2,000 horsepower gears have been in service for over three years driving direct

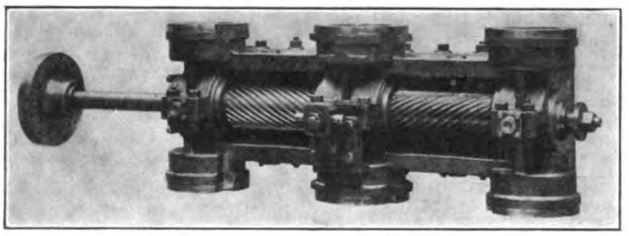

Fig. 9.—Hydraulic Floating Frame with Pinion in Place, Showing Flexible Driving Shaft and Coupling, and the Cylinders Which Support the Floating Frame and Form the Dynamometer for Measuring the Power Transmitted

current generators. Two of the 6,000 horsepower gears, which also drive direct current generators, have been in service for more than a year and a half and have proved most satisfactory in every way. The gears installed on the U. S. S. *Neptune* were tested under all of the various service conditions, and were found entirely satisfactory by the Navy Department. The fact that all of these large gears without exception have operated with entire satisfaction, and that there have been no failures whatever in large gears, should be ample assurance that they are, beyond question, absolutely reliable. They are completely removed from the experimental stage, and, as experience has proved conclusively, they are entirely suited for marine service.

While 67,000 horsepower, such as would be needed for the *Vaterland*, is tremendous, the gears required would be but very little larger than the ones already built, and would be well within the possibilities demonstrated. The power transmitted by each of the eight pinions would be only 8,300, or but 2,300 horsepower more than the 6,000 horsepower experimental gear. If it were desirable, 50,000 horsepower could without difficulty be transmitted

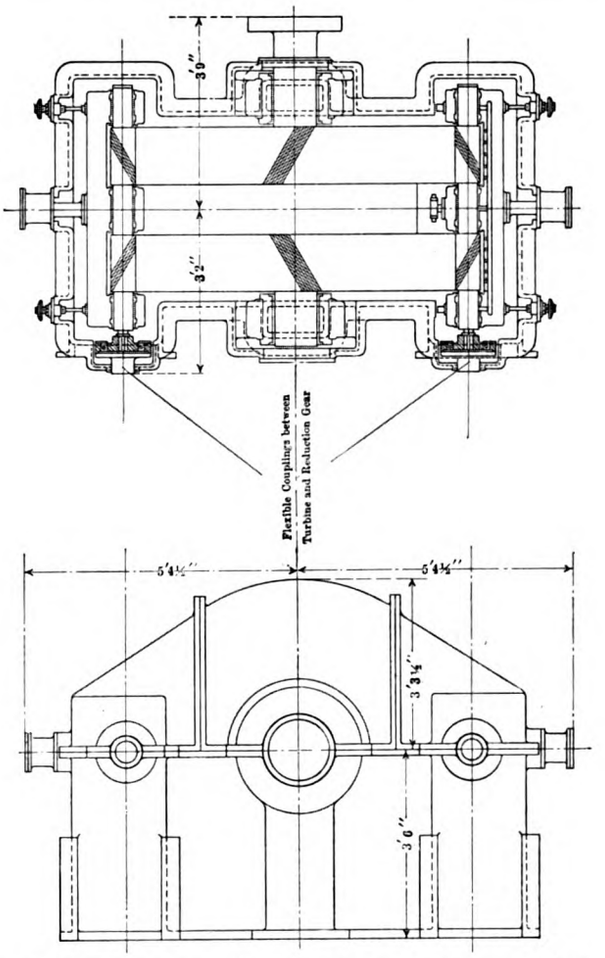

Fig. 10.—Reduction Gear for U. S. S. *Pennsylvania*. Revolutions per Minute, 1,800 to 120; Shaft Horsepower, 1,600; Diameter of Gear, 70 Inches; Weight, 30,000 Pounds

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to each shaft, as compared with the 16,600 per shaft in this case. It is plain, therefore, that even the greatest powers which are contemplated for driving vessels can be transmitted through gears without difficulty.

The success of the large gears built by the Westinghouse Company, and their ability to transmit large powers, are due to the hydraulic floating frame, which automatically alines the pinion and the gear under all conditions of load, so as to distribute the load uniformly over the entire length of the broad gear faces, thus avoiding intense local pressure which would otherwise occur. The floating frame gear can be overhauled and assembled quickly by ordinary mechanics with the absolute assurance that it will run perfectly and be absolutely dependable. The hydraulic cylinders which carry the floating frame afford a simple and accurate means of measuring the power. The absence of vibration and noise is due to the fact that there is no metallic connection between the pinion and the gear box, and also that the pinion frame floats on oil, which, due to the entrained air, has a cushioning effect resulting in unusual smoothness and quietness of operation.

Reduction Gears Suitable for Slow Freighters

The savings which may be effected in smaller vessels by the use of geared turbines are no less important than those for large express steamers. In fact, they are a great deal more important because of the greater aggregate power in medium and small size vessels. As compared with reciprocating engines, with which most moderate speed vessels are equipped, the saving in steam and coal consumption in favor of geared turbines is found to be from 15 to 25 percent in most cases. The advantages and financial saving resulting from this improvement in economy should be apparent from the above.

The following specific comparison will illustrate briefly the savings which may be effected in slow speed vessels:

1. *Large Freight Steamer.*—Speed, 14 knots; revolutions per minute of propeller, 90; shaft horsepower, 5,500; steam pressure, 200 pounds.

	Triple-Expansion Engine.	Geared Turbine.	Percent Saved.
Steam consumption for all purposes—			
Steam consumption per I. H. P.....	15.0	11.1	25.7
Steam consumption per S. H. P.....	16.3	12.1	25.7
*Coal consumption per I. H. P.....	1.5	1.1	25.7
Coal consumption per S. H. P.....	1.63	1.21	25.7

* Actual evaporation, 10.0 pounds.
Saving in total weight of machinery, 29 percent.

2. *Slow Freight Steamer.*—Speed, 10 knots; revolutions per minute of propeller, 70; shaft horsepower, 2,500; steam pressure, 180 pounds.

	Triple-Expansion Engine.	Geared Turbine.	Percent Saved.
Steam consumption for all purposes—			
Steam consumption per I. H. P.....	15.5	11.8	23.5
Steam consumption per S. H. P.....	16.75	12.8	23.5
Coal consumption per I. H. P.....	1.55	1.18	23.5
Coal consumption per S. H. P.....	1.68	1.28	23.5

Saving in total weight of machinery, 27 percent.

From a commercial viewpoint the large savings which may be obtained by using geared turbines are most attractive. No doubt they will be compelling within a short time. In some cases the first cost of geared turbines may be slightly higher than reciprocating engines, but when the savings are capitalized it is found that engines are the most expensive at almost any price. In some cases it is found that it would not pay to put in an engine, even if it were obtained absolutely free.

Advantages of Reduction Gears in Naval Vessels

In naval vessels the military advantages of geared turbines are quite as great and important as are the commercial advantages in merchant vessels. The saving in weight and space required for the machinery makes it possible to considerably increase the gun power or armor protection. In the case of the *Nevada,* for example, the saving in the weight of machinery and coal would make it possible to add another turret, with the necessary ammunition, etc., thus increasing the battery from ten to twelve 14-inch guns, or, in other words, increasing her defensive power by 20 percent.

One of the most important advantages of geared turbines for naval vessels is their high efficiency at cruising speed, in which respect the direct-drive turbine has been found lamentably lacking. This is well illustrated in Fig. 5. These curves would also apply to merchant vessels of about the same power and speed. As the curves for the reciprocating engine are based on the *Delaware* and *Texas,* which have exceptionally efficient engines, they are somewhat better than the average results obtained with this type.

The following comparisons will illustrate the advantages of geared turbines for naval vessels:

1. *Battleship.*—Speed, 21 knots; shaft horsepower, 28,000; steam pressure, 250 pounds.

	Direct-Drive Turbine.	Geared Turbine.	Percent Saved
Revolutions per minute of propellers.	320	125	
Steam consumption in pounds per effective horsepower per hour in driving vessel at full speed..... (Turbines only.)	21.2	15.0	29
Same at cruising speed.....	27.8	17.0	38

SAVING IN WEIGHT (TONS)

	Direct Drive.	Geared Turbines.	Actual Saving.	Percent Saved.
Main turbines only.....	650	300	350	54
Other propelling machinery, boilers, auxiliaries, etc.....	910	673	237	26
Ship's auxiliaries (not part of propelling machinery)	500	500	0	0
Propelling machinery only.....	1,560	973	587	37½
All machinery	2,060	1,473	587	28½
Fuel (full capacity)	2,500	1,730	770	31
All machinery and fuel.....	4,560	3,203	1,357	30

2. *Destroyer.*—Speed, 30 knots; shaft horsepower, 18,000; steam pressure, 250 pounds.

	Direct-Drive Turbine.	Geared Turbine.	Percent Saved
Revolutions per minute of propellers	600	450	
Steam consumption in pounds per effective horsepower at full speed.. (Turbines only.)	19.5	15.5	20
Same at cruising speed.....	28.5	18.0	37

Saving in total weight of machinery .....22 percent
Saving in total weight of fuel .....31 percent
Saving in total weight of machinery and fuel.....28 percent

With geared turbines the additional complication and weight of cruising turbines are not required. With respect to backing power and quick maneuvering, which are very important in naval vessels, the direct-drive turbine has not been entirely satisfactory because of the small propellers and restricted astern power. Because of the large propellers, which "take hold of the water," and the ample backing power which can be obtained in high-speed turbines, the backing and maneuvering qualities of geared turbines are quite satisfactory and practically as good as obtained with reciprocating engines. This is also an important consideration in merchant vessels, especially those which have to be handled around docks.

The advantages of geared turbines for propelling vessels, both naval and merchant, are of the greatest importance. Now that the reduction gear has made it possible to realize the full advantages of the turbines, its rapid adoption seems certain. A few years ago the turbine wiped out the reciprocating engine on land. It now appears that this same stage has been reached at sea, and that here also the turbine will wipe out the reciprocating engine.

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The New Niclausse High-Duty Marine Boiler*

Thermal Efficiency of 91.5 Percent Obtained at Combustion Rate of 19.5 Pounds of Coal per Square Foot of Grate Area

BY JULES NICLAUSSE

In the Niclausse boiler all the evaporating tubes are fitted at one end only into the headers, and a perfectly tight joint is insured by metal-to-metal conical joints. The other end is closed by a cap and is carried by a supporting plate. The removal of any tube, either for cleaning or for replacement, is very easily and rapidly effected, so that a shut-down for any cause does not put the boiler out of service for more than a relatively very short time. The tubes being fixed at one end only, expansion or contraction takes place freely, giving complete security against troubles resulting from neglect of this important provision. It will be noticed from Fig. 1 that the old screwed-on lantern end has been suppressed, the tube being now solid drawn throughout, with swellings to form the cones.

As shown in Fig. 1, each header is divided into two compartments by a vertical partition plate, separating the steam and water currents. The current of water flowing through the front compartment of the header is distributed to each evaporating tube by an inner tube contained in the former. Windows cut in the header end of the evaporating tube enable the water to enter and the steam to depart in two distinct currents, so that positive circulation in only one, and that the correct direction, is insured.

During the last two years a number of improvements have been made in the details of the Niclausse boiler, without affecting the principles of its operation and construction. Some years ago the malleable cast steel curved headers were replaced by headers constructed in solid drawn pressed steel of increased and of rectangular section, and recently the firm introduced a special system of feed distribution to serve the lower tubes, which are those nearest the furnace, and are the principal evaporating tubes. For this purpose, the steam and water drums are divided into two compartments by a longitudinal diaphragm plate in prolongation of the vertical partitions in the headers as shown in Fig. 2; the feed, after passing through a trough *C* wherein carbonates and other impurities are precipitated, and whence they are ejected by means of a blow-down valve *D*, enters at the front compartment, descends the vertical headers for a certain distance determined by a cross diaphragm *E*, passes into the upper evaporating tubes and returns with the steam there produced into the back compartment of the drum, which consequently contains only hot and purified feed. The purified feed then descends by two tubes placed in front of the side walls, in the case of the high-duty boiler, Fig. 3, into a square horizontal header located longitudinally in front of, and connecting by an elbow to the bottom of each of the vertical headers. The upper tubes are therefore fed by relatively cold feed-water, and the bottom tubes by the purified hot feed. The horizontal header also serves as a "bottom box," Fig. 2, whence impurities can also be rejected by blow-down valves *F* fitted at each end of it.

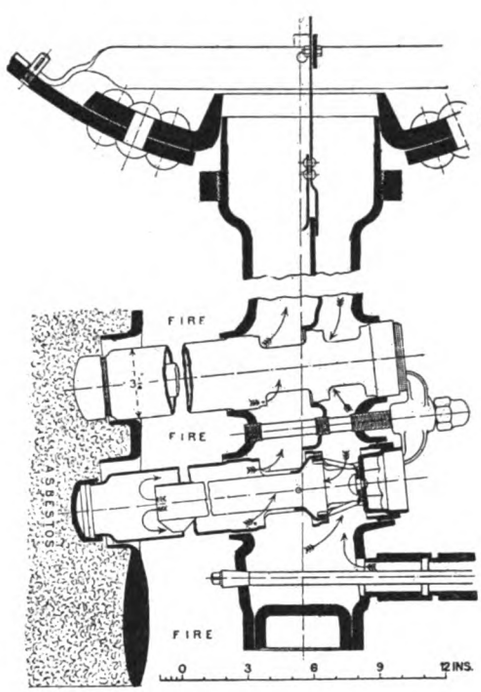

Fig. 1.—Header and Evaporating Tube Ends

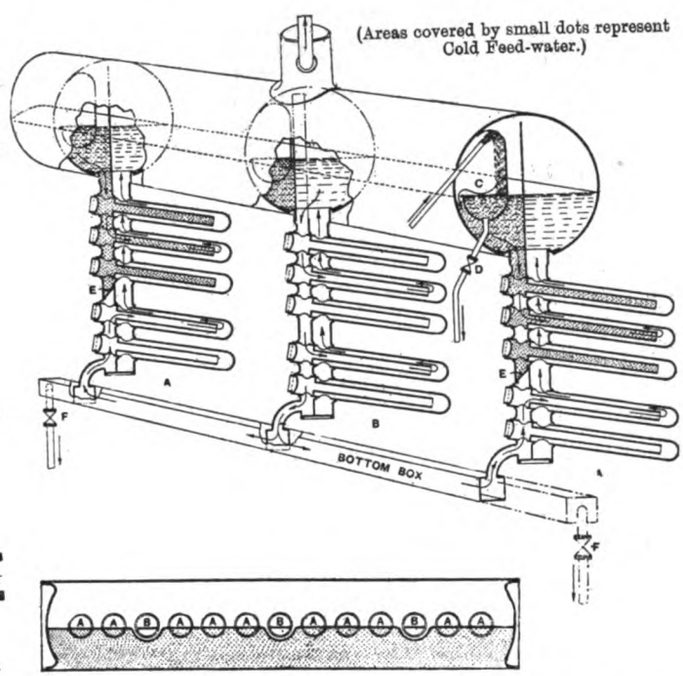

Fig. 2.—Diagram of Water Circulation in Land Type of Boiler

The lower tubes, which are most exposed to the heat of the furnace, consequently receive the feed at boiler steam temperature and free from any impurities which can cause deposit. Any impurities in the feed to the upper tubes are practically harmless, since the temperature of the gases surrounding them is insufficient to form a hard scale.

In the modern land type boilers the system is simplified, without impairing its efficiency, by suppressing the verti-

* Extract from a paper read before the Institution of Mechanical Engineers in Paris, July, 1914.

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cal downtake pipes. These are replaced by one header out of every four or five, in which no cross diaphragm is fitted in its front compartment, so that it serves to feed the "bottom box" and the lower tubes of all the headers fitted with the cross diaphragm, while its own lower tubes are served direct. The arrangement will be quite clear from Fig. 2, *A* being headers having the cross diaphragm in their front compartment taking impurified feed from the front side of the drum to feed the upper tubes, *B* being a downtake header taking its hot purified feed-water from the back side of the drum, the division plate therein being suitably arranged for this purpose, as shown at *B* in plan.

In the new high-duty marine type boiler, the firm have still further increased the section of the headers, chiefly in the rear compartment forming the passage for the steam. This is about 4½ times larger than in the modern land type headers. Furthermore, an inclination of 15 percent instead of 10 percent has been given to the tubes, in order to facilitate disengagement of the steam. Also, the outside diameter of the tubes has been reduced from 3 5/16 to 2⅜ inches, a reduction which has been rendered practicable, with complete security against all forms of distress, by the above-mentioned improvements.

The new high-duty boiler is fitted with a feed-reheater placed above the tubes. The water circulates into this apparatus on the contra-flow principle—that is, in the reverse direction to the hot gases. The official tests referred to hereafter show the efficacy of this feed-reheater, as much from the point of view of the feed-water temperature as from that of the chimney-gas temperatures.

The high-duty marine boiler, having no superheater as usually arranged between the tubes in the land type, is fitted with a new system of gas baffling, which doubles the length of the gas flow in the tube "faisceau," ensuring improved utility and efficiency. This comprises plain open-ended tubes laid between the evaporating tubes, forming gas passages, as will be seen from Fig. 3.

All the above improvements were comprised in the test boiler recently tested by the French navy experts. Full dimensions of this boiler are given in Table I, together with a drawing showing its general arrangement, Fig. 3. The tests of this boiler by the committee of naval experts appointed by the French Admiralty, and carried out in September last, comprised:

(1) A six-hour trial at the combustion rate of 19.5 pounds of coal per square foot of grate surface. The evaporation in pounds from and at 212 degrees F. was 13.1 per pound of coal fired, the thermal efficiency being 91.5 percent, and the capacity 20,000 pounds per hour from and at 212 degrees F.

(2) A six-hour trial at the combustion rate of 37 pounds of coal per square foot of grate surface. The evaporation in pounds from and at 212 degrees F. was

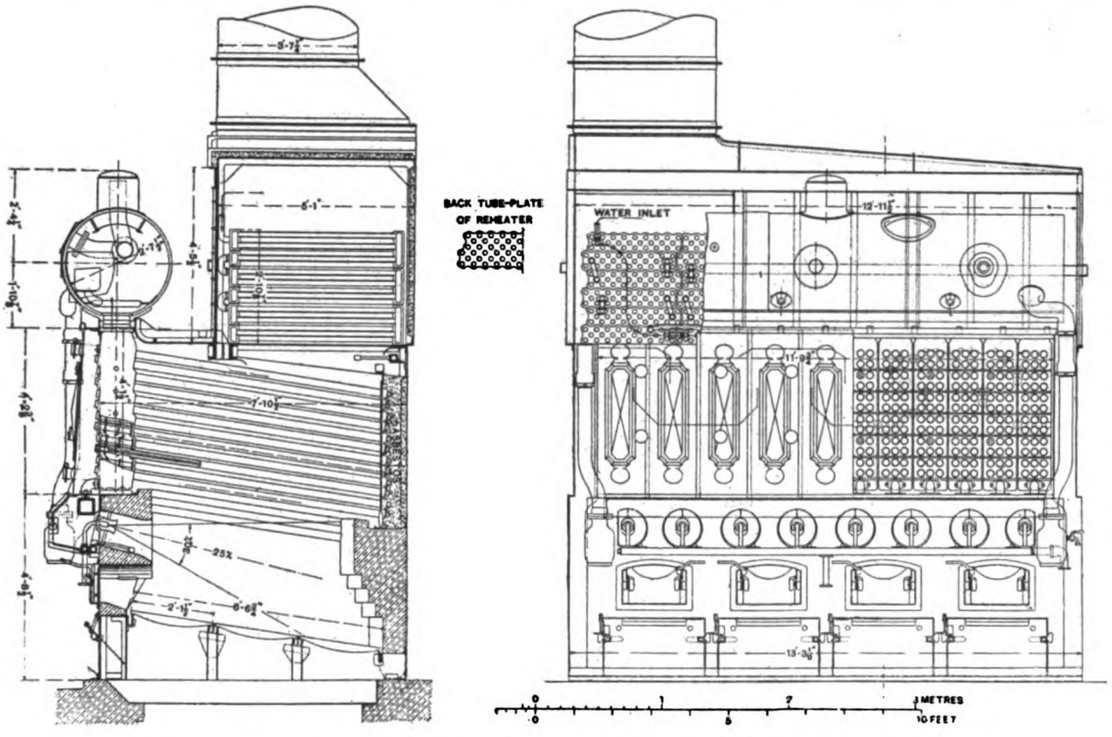

Fig. 3.—High-Duty Marine Boiler for New Battleship *Bearne*

11.5 per pound of coal fired, the thermal efficiency being 79.8 percent.

(3) A sixteen-hour trial at the combustion rate of 46 pounds of coal per square foot of grate surface. The evaporation in pounds from and at 212 degrees F. was 11.4 per pound of coal fired, the thermal efficiency being 79.3 percent, and the capacity 41,000 pounds per hour from and at 212 degrees F.

(4) A four-hour trial at the combustion rate of 28 pounds of petroleum per square foot of grate surface. The evaporation in pounds from and at 212 degrees F. was 15.5 per pound of fuel burnt, the efficiency being 78.8 percent.

(5) A five-hour trial to demonstrate the elasticity of the boiler. Operation took place as follows: Half an hour at the combustion rate of 19.5 pounds per square foot of grate surface; half an hour at the combustion rate of 37 pounds; half an hour at the combustion rate of 46 pounds; one hour at the combustion rate of 49.2 pounds; a quarter of an hour at the combustion rate of 37 pounds; a quarter of an hour stop; ten minutes at the combustion rate of 19.5 pounds; three-quarters of an hour at the combustion rate of 28 pounds with oil fuel; a quarter of an hour at

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the combustion rate of 19.5 pounds of coal. This trial proved that the boiler made the change from these different rates with perfect success, and without any difficulty.

Further tests were made on January 6 last by a party of English engineers. The results fully corroborated those obtained by the French naval experts.

During the No. 3 trials, the percentage of water entrained was at maximum only 0.9 percent. This was determined by the salt method with the Kennedy apparatus. The maximum temperature of the gases at foot of chimney was only 625 degrees F. during the sixteen-hour test at the combustion rate of 46 pounds per square foot, when the evaporation was 105 percent above the normal. It must be added that the feed-water used was the ordinary town water, which was not in any way treated or purified, and which during the official tests was subjected to an addition of such a quantity of sea salt as to give one degree of salinity to the water in the boiler. Valvoline was also added in the proportion of 175 grammes per ton of coal fired. On the results of the tests made by naval experts in September last, the French Admiralty placed with the firm an order for twenty-one boilers aggregating 36,000 horsepower for the 25,000-ton super-dreadnought *Bearne* laid down on January 1 of this year.

TABLE I.—PARTICULARS OF THE BOILER SUBMITTED FOR TRIALS BY THE NAVY

The general arrangement of the boiler is shown in Fig. 3. Other particulars are as follows:

Working pressure (gage)	256 pounds per square inch
Number of headers	13
Number of evaporating tubes, upper	300 (thickness, 0.099 inch)
Number of evaporating tubes, lower	156 (thickness, 0.16 inch)
Total number of tubes	456
Cleaning tubes	12
Outside and inside diameter of upper tubes	2.36 inches x 2.16 inches
Outside and inside diameter of lower tubes	2.36 inches x 2.04 inches
Height of headers	7 feet 6 inches
Length of tubes projecting outside the headers	6 feet 7¼ inches
Number of tubes in economizer	780
Length of economizer tubes (outside headers)	4 feet 0 inches
Length of grate	6 feet 6 inches
Width of grate	11 feet 9½ inches
Grate area	77.5 square feet
Heating surface of outer tubes	1,870 square feet
Heating surface of economizer	1,285 square feet
Total heating surface	3,155 square feet

The ratio of outer heating surface of the tubes (neglecting the header surface) to the grate surface is:

Outer surface of evaporating tubes	24.11 to 1
Outer surface of economizing tubes	16.56 to 1
Ratio of total heating surface to grate area	40.67 to 1

Space occupied by boiler = 114 square feet; height to top of dome, 13 feet.

Hourly evaporation per square foot of ground space occupied:

(*a*) At normal load, with rate of combustion of 19.5 pounds per square foot of grate surface = 175 pounds per hour from and at 212° F.

(*b*) At overload, with rate of combustion of 46 pounds per square foot of grate surface = 355 pounds per hour from and at 212° F.

A Reprieve for the Big Fore-and-Afters

The probability of a new lease of life for the big schooners of the Atlantic coast is seen in the recent departure of the five-master *Dorothy B. Barrett* from Norfolk, Va.,with a cargo of coal for Seattle, Wash., via the Panama Canal. With fair conditions she should make the passage as quickly as the steamers that have heretofore carried the same commodity through the Straits of Magellan; return with sugar, lumber or some other freight, the prompt delivery of which is not a necessity, and solve the serious problem of the disposition of her class of vessel, of which many staunch specimens have been in danger of being left hopelessly superannuated while yet in the prime of existence.

For many years the huge fore-and-afters of the *Barrett's* type continued to flourish in the protected domestic trade, while foreign-going "windjammers" were being hounded from the seven seas by the encroachments of steam. But then into the coastwise coal trade came the tugs and barges, and later fine steel steamers, many of them lake-built. This summer despairing owners have laid the big sailers up by scores at all the north Atlantic ports, with little hope of their ever finding occupation again unless converted into barges. So the opening revealed by the *Barrett* comes at an opportune time.

It is true that vessels of the *Barrett's* rig are essentially coasters. They lack the squaresail or raffee forward worn by the big Pacific fore-and-afters which regularly go offshore, though the four-master *Haroldine,* built at Weymouth, Mass., when the many-master was a novelty, wore such an innovation, which was removed after she made a few voyages. But the short cut at Panama which halves the length of the coast-to-coast voyage will practically put the fore-and-after on an equal footing with the offshore-going craft. Hereafter she will merely be going coastwise, and Cape Horn will hold no terrors for her.

Moreover, these big coasters have had quite an extensive acquaintance with "Cape Stiff" years before this. The pioneer five-master *Governor Ames,* built at Waldoboro, Me., in 1888, went to San Francisco when new, badly beat several square-riggers which sailed from this side at the same time, and made much better work of it than the Port Townsend four-master *William Nottingham,* which brought a cargo of spars from Puget Sound to Boston a few years ago. The *Ames* was wrecked with a loss of eleven lives on Wimble Shoals, N. C., December 13, 1909.

The *Kineo,* of Bath, the only steel five-mast schooner ever built and still in service, carried a cargo of coal from Norfolk, Va., to Manila and returned with Hawaiian sugar to Philadelphia, also making a couple of voyages in the Pacific before returning. The *Haroldine,* before mentioned, made a successful trip to Melbourne, while the four-sticker *Susie M. Plummer* a few years ago was sold to Pacific owners and ended her days as a derelict recently on the other side.

Big schooners, too, have figured rather extensively in other deep water trades. The *Mary F. Barrett,* a sister ship of the *Dorothy,* not long ago carried a cargo of lumber to the River Platte, as did the five-sticker *James W. Paul, Jr.* Four-masters commonly engage in this trade, and until the last few years did so in that to the West Coast of Africa. The *George W. Wells,* the first six-master built, which was wrecked south of Hatteras September 5, 1913, carried coal from Philadelphia to Havana on her first trip, making a record passage.

The big four-master *Edward T. Stotesbury,* now the *Blanche C. Pendleton,* carried case oil from Philadelphia to Liverpool on her maiden voyage, and the *Medford,* of similar rig, lost in a hurricane at Knight's Key, Fla., a few years since, made her début with a coal freight from Philadelphia to Lisbon, Portugal. The ill-fated voyage of the huge steel seven-master *Thomas W. Lawson* from the Quaker City to London can scarce be quoted as an inducement to owners to embark in offshore trades, since she was lost on the Scilly Isles December 13, 1907.

However, there are afloat on the Atlantic coast to-day 8 six-, 25 five- and 158 four-mast schooners of 259,175 gross tons. Many are not fit to go to Seattle, but many more are, and the *Dorothy B. Barrett* is one of these. She is of 2,088 tons, and was built at Bath ten years ago by Gardiner G. Deering, who also is her owner.

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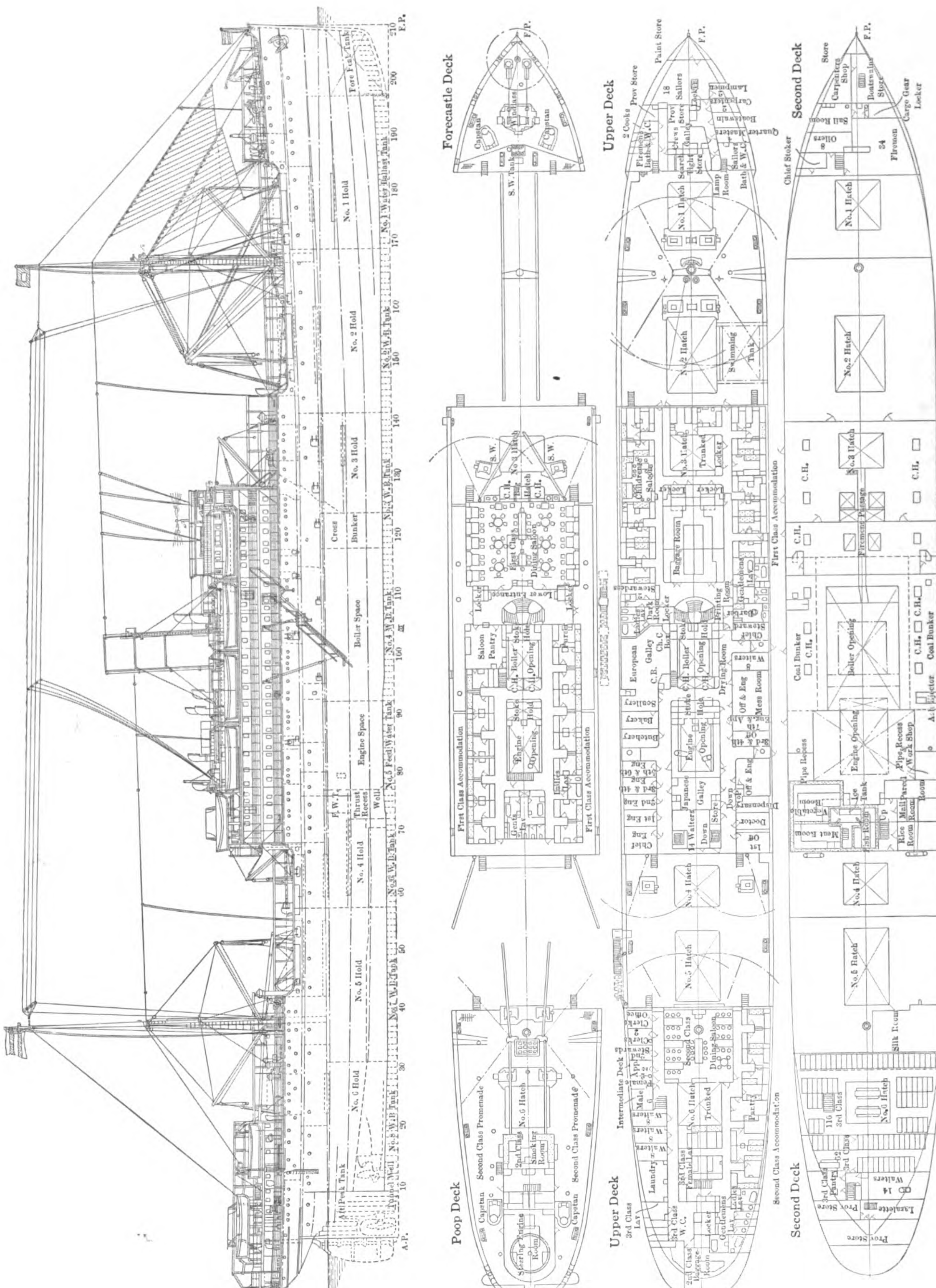

Fig. 1.—Profile and Deck Plans of the *Katori Maru* Built by the Mitsu Bishi Dockyard and Engine Works of Nagasaki for the Japanese Mail Steamship Company, Ltd.

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A New 10,000-Ton Japanese Mail Steamship

Description of the Latest Addition to the Japanese Mail Steamship Company's Fleet of Eighty-Three Steamships

The most important shipping company in the Far East is the Nippon Yusen Kabushiki Kaisha (the Japanese Mail Steamship Company, Ltd.), which operates a fleet of eighty-three steamships and maintains regular services from Hong-Kong, Kobe, Yokohama and several other Japanese ports to India and practically all parts of the Far East, to Australia, London, Seattle and Victoria, B. C. The latest addition to this company's fleet is the triple-screw steamship *Katori-Maru,* which was built and engined by the Mitsu Bishi Dockyard & Engine Works, of Nagasaki. The new vessel has the following dimensions:

Length overall	510 feet
Length between perpendiculars	490 feet
Breadth, molded	61 feet
Depth, molded	36 feet 6 inches
Load draft	28 feet
Load displacement	18,750 tons
Gross tonnage	10,512 tons
Trial speed	16.75 knots

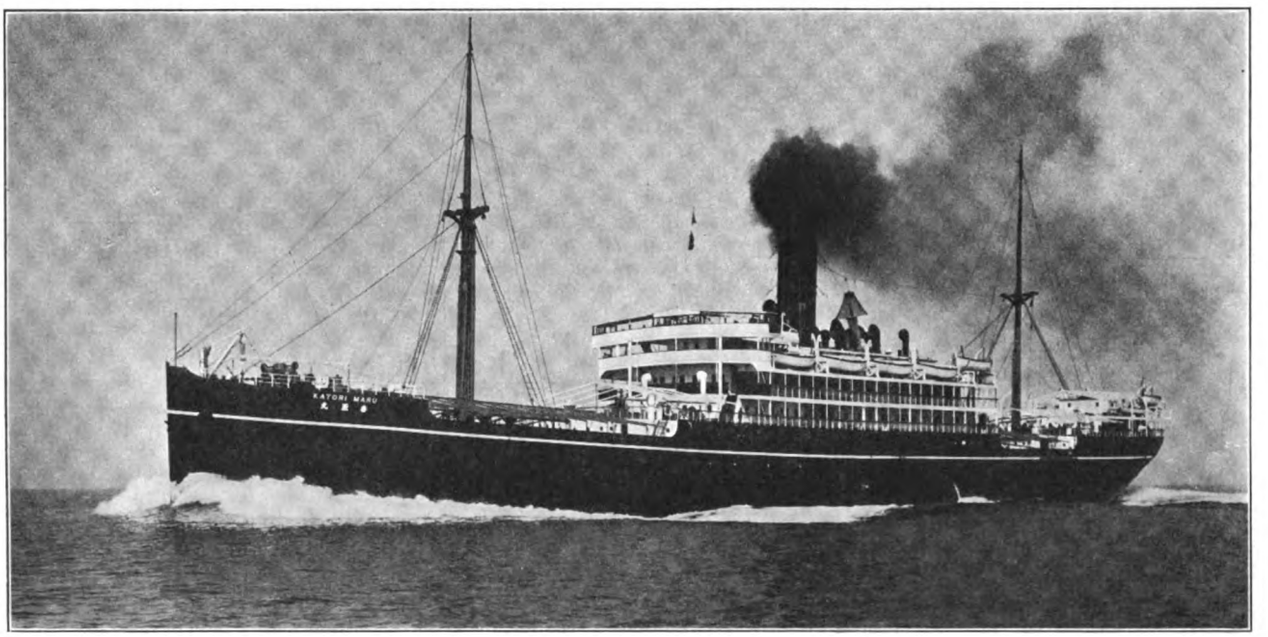

Fig. 2.—Triple-Screw Steamship *Katori Maru* of 18,750 Tons Displacement and 11,700 Horsepower

As will be gathered from the general arrangement drawing, the *Katori-Maru* has six decks, two of which extend from end to end of the ship. There is a continuous double bottom of 1,817 tons capacity extending from the collision bulkhead to the after peak bulkhead. The hull is divided into six compartments by extra strong watertight bulkheads.

The promenade bridge, upper and main decks contain the first class staterooms for 112 passengers, including suites of rooms, cabins for 56 second class and 8 special third class and 178 bunks for third class passengers.

The first class social hall, smoking room and suites of rooms are situated on the promenade deck. The social hall is of satinwood and smoking room of nara (Japanese oak). They are very tastefully decorated in mixed Japanese and Western style. The first class dining saloon is on the bridge deck, constructed of white oak and very luxuriously decorated. There are seats for 90 passengers at small tables. Just opposite this saloon is a roomy pantry. On the upper deck is the children's saloon, decorated with Japanese paintings. Besides these there are all manner of smaller rooms necessary for long voyages, such as a dark room, consultation room, barber's shop and a laundry. The staterooms are on the promenade, bridge and upper decks. All of them are at the sides of the ship, and there are no inside rooms.

The second class accommodation is situated aft. The dining room, to seat 44 persons, is plainly yet neatly finished. The smoking room is situated on the poop deck. The second cabins, too, have no inside rooms.

There are 120 small electric ventilating fans in the first and second class quarters. The ship is lighted throughout by electric lamps numbering more than 800 in all. Three arc lamps, one of 16,000 candlepower for a searchlight, and two of 3,000 candlepower are provided.

On the main boat deck the captain's room and officers' quarters are situated forward, and the radio-telegraphy room and Clayton's fire extinguishing apparatus room aft. On each side of the same deck ten lifeboats are placed under Welin patent boat davits. On the after deck is a hospital, and on each side three lifeboats and one temma (a light junk).

The refrigerating machinery, to cool a chamber of 4,600 cubic feet capacity, was made by Messrs. J. & E. Hall, Ltd., of Dartford. The deck machinery includes a Na-

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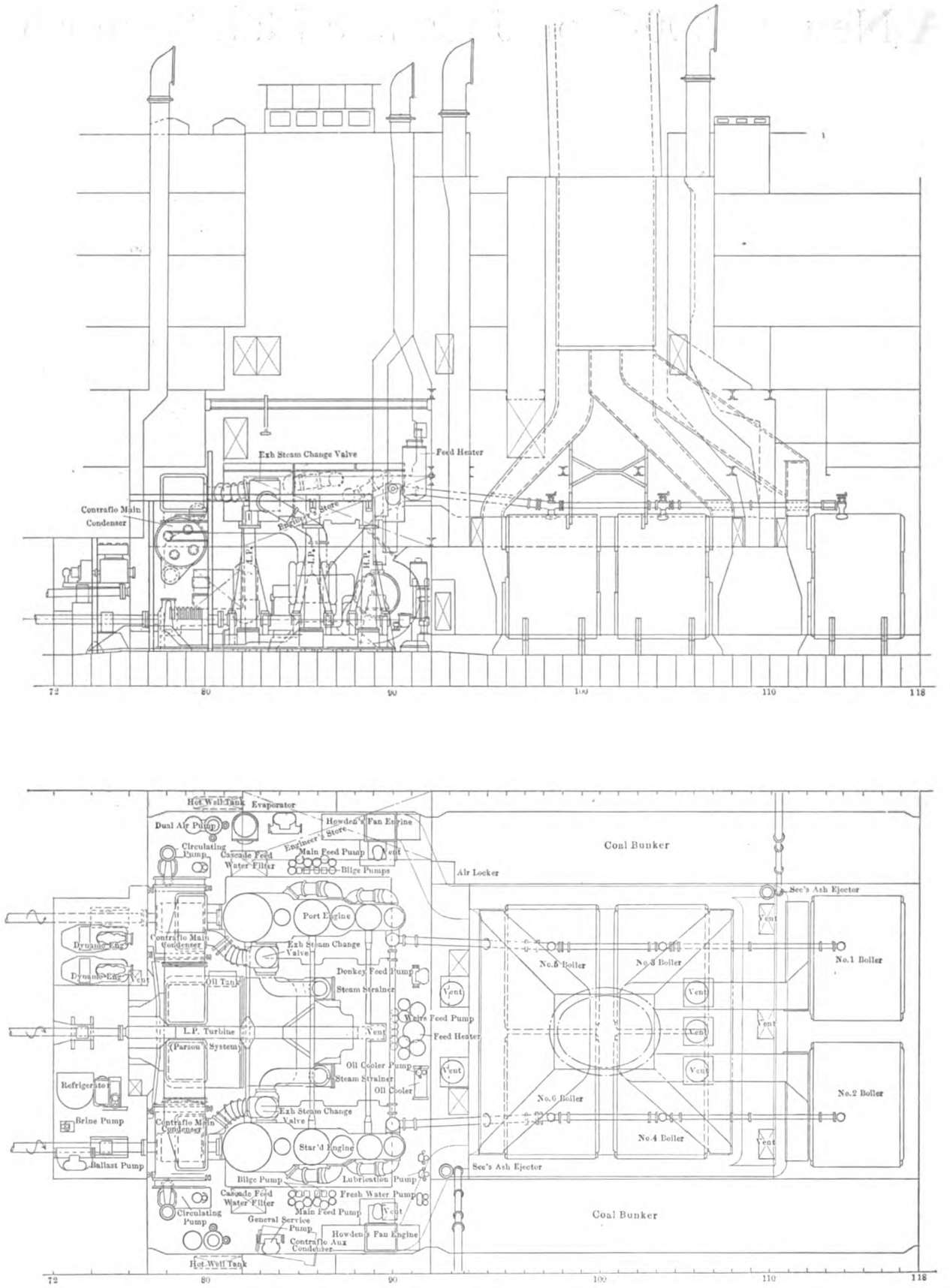

Fig. 3.—Longitudinal Section and Plan of the Machinery Space, S. S. *Katori Maru*. Wing Screws Driven by Triple Expansion Reciprocating Engines and Center Screw by Low-Pressure Parsons Turbine. Total Indicated Horsepower, 11,700

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pier's windlass and twelve winches of from 3 tons to 40 tons capacity, six of them being of Wilson's noiseless pattern. A Caldwell's steering gear, with telemotor connection, has been fitted.

The main machinery is composed of two triple-expansion reciprocating engines and one exhaust turbine of Parsons type. The former drive the wing shafts and the latter the center shafts. The aggregated indicated horsepower is 11,700. The diameters of the cylinders of the reciprocating engines are 27 inches, 42 inches and 66

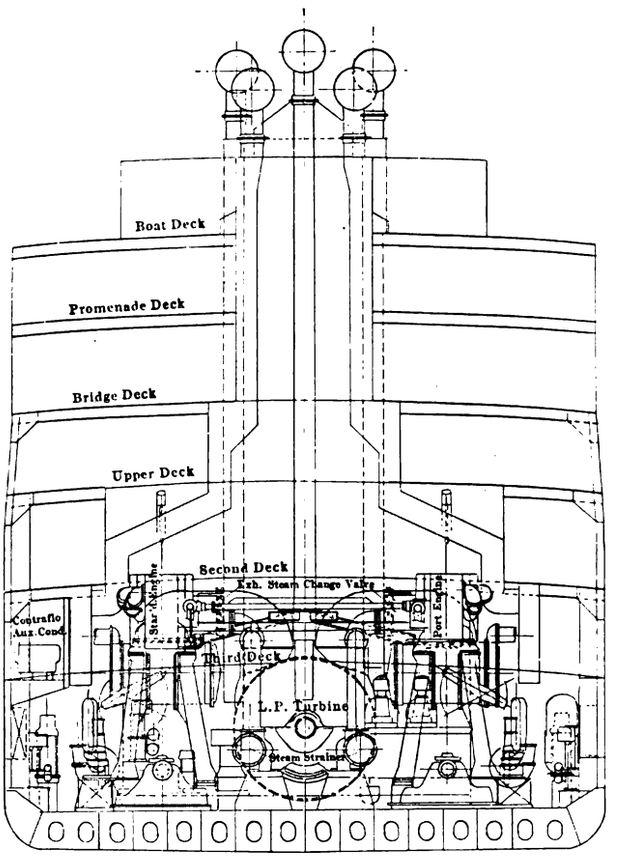

Fig. 4.—Section Through Engine Room

inches, with a stroke of 48 inches. The rotor drum of the turbine is 11 feet 1 inch diameter and 10 feet in length. The main and auxiliary condensers are on the Contraflo system.

Steam is generated by six Scotch boilers, 15 feet 6 inches diameter and 11 feet 9 inches long, working at a pressure of 200 pounds per square inch. The draft is the Howden system.

The *Katori-Maru* was built under the special survey of the Japanese Government surveyors to meet the requirements of the Shipbuilding Encouragement Law, and also to Lloyd's highest class.

Boston's Square-Riggers

Ralph C. Emery, of Boston, Mass., recently sold the barkentine *Allanwilde* to Scammell Brothers, of New York, and the transaction reduced the number of square-riggers owned in Boston to four.

Two of the quartet are barkentines of the Emery fleet. The *John S. Emery* runs regularly in the export lumber trade between Boston and South America, and is commanded by Capt. Davis. She is of 803 net tons and was built at Boston in 1890. The *Kremlin,* built at Bath, Me., in the same year, is employed in the southern coastwise lumber trade in charge of Capt. Leland. Two years ago she was nearly destroyed by fire at Portland, Me., and lately has been rebuilt. She is of 698 net tons.

Boston's last bark, the *Onaway,* is owned by Crowell & Thurlow, who purchased her a few years ago from the Winslow Company, of Portland. She is commanded by Capt. Goldthwaite, and is used at present in the molasses trade between Porto Rico and Boston. The *Onaway* is of 883 net tonnage and was built in 1883 at Yarmouth, Me.

The 1939-ton *Aryan,* the last full-rigged ship built in the United States and the only one now owned on the Atlantic coast, is the property of Eugene P. Carver. In late years she has been in the coast-to-coast trade via Cape Horn, but has recently taken a load of lumber from Puget Sound to South Africa, where she is at this writing. Two years ago she was overdue on a voyage from Baltimore to Seattle with coal, but turned up safely when 154 days out. The *Aryan* was built at Phippsburg, Me., in 1893.

Alteration of Ferryboat Pittsburgh

The ferryboat *Pittsburgh,* of the Pennsylvania Railroad Company, has recently undergone some extensive alterations at the Hoboken shops of that company, for the purpose of providing further accommodations for teams. The vessel is of the double-ended ferryboat type, 200 feet long, 46 feet beam and 15.4 feet draft, and is propelled by two compound engines of 1,800 indicated horsepower. Steam is supplied at 200 pounds working pressure by four watertube boilers.

The alterations represent the removal of the lower cabins, stairways, and upper deck enclosure, so that an additional team gangway on each side of the boat could be provided. In lieu of the inboard bulkheads of cabins, which were removed, the following has been substituted to assist in the support of the upper deck: 9 columns of 6-inch I-beams, 12.25 pounds per foot, and two 6-inch H-beams, 23.8 pounds per foot, and one 6-inch pipe column with cast iron base, forming a wheel guard, on each quarter; and on each end at the center one built column of four angles, 3 inches by 2½ inches by ⅜ inch plate 6 inches wide. The girders, except at ends, are made of 8-inch I-beams, 18 pounds per foot, and at the ends are of four angles 4 inches by 3 inches by ⅜ inch, with plate ½ inch by 9 inches by 13 inches deep. From the center to the end columns, two lattice girders of four angles 2½ inches by 2½ inches by 5/16 inch and 2 inches by ¼ inch lattice. On the side columns, 6 feet from the deck, a lattice stiffener is fitted of two angles 3 inches by 2½ inches by 4½ pounds and 2 inches by ½ inch lattice.

On each side of the outboard combing is a passageway, the whole length of deck, and on each side an iron stairway has been fitted from this passageway to the upper deck, for emergency use only. The outboard coamings have an easy line to facilitate the ready loading and unloading of teams. All of the sides and ceiling of the main deck enclosures were lined with non-inflammable "Nevasplit" sheathing. All windows have been removed from the outboard coaming, excepting 20 on each side. Proper lighting facilities for the gangways have been provided by means of ten incandescent lamps on each side. On each end, in addition to the gates, is fitted a ⅝-inch wire cable which is connected to a drum underneath the deck, so weighted as to house the cable when not in use; this cable has been installed principally as a safety device to prevent progress of an automobile improperly started.

The shape of the hull of this boat was very much

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adapted to the improvements made—that is, the flare on the sides of her hull will come inboard on the main deck about 1 foot 6 inches from the outboard team gangway coaming, and this, with her general stability, amply takes care of any lists.

The Development of Mechanical Gearing for Marine Turbine Machinery

BY ERNEST H. B. ANDERSON *

Rapid progress continues to be made in the development and in the constructional details of mechanical gearing for ship propulsion. At the present time the total shaft horsepower of Parsons geared turbine machinery in vessels actually in service amounts to 62,500, and there is under construction an additional 650,000 shaft horsepower.

At present all merchant vessels in service fitted with this means of drive are operating in Great Britain and the Colonies, but there is being built in the United States 35,000 shaft horsepower of mechanical gearing, all of which is to be driven by Parsons turbine machinery installations for use in the United States Navy or for the auxiliary vessels connected with the fleet. Among the vessels completed abroad, the following may be mentioned and full particulars of the machinery installation, trial trip and service performances may be found in the proceedings of various technical societies or in engineering journals.

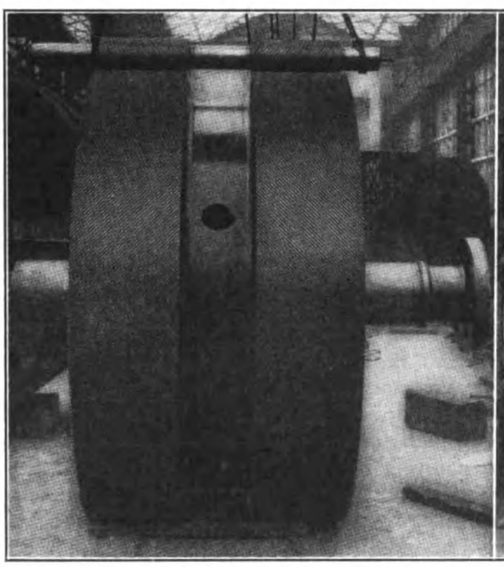

Fig. 1.—Finished Gear Wheel and Pinion

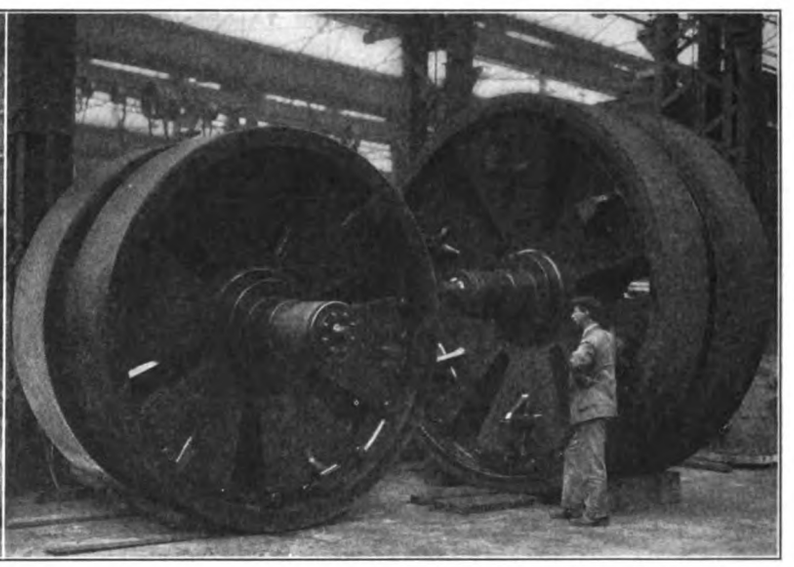

Fig. 2.—Gear Wheels Assembled

GEARED TURBINE INSTALLATIONS

1. Steamship *Vespasian*, 1,000 shaft horsepower (Institution of Naval Architects, 1910 and 1911).
2. Steamships *Hantonia* and *Normannia*, 5,000 shaft horsepower (Institution of Naval Architects, 1912).
3. Steamship *Cairnross*, 1,700 shaft horsepower (North East Coast Institution of Engineers and Shipbuilders, 1913).
4. Steamships *Curzon*, *Hardinge* and *Elgin*, 2,500 shaft horsepower (Institution of Naval Architects, 1913).
5. Steamship *King Orry*, 8,000 shaft horsepower (*Engineering*, June 27, 1913).
6. Steamship *Paris*, 14,000 shaft horsepower (*Engineering*, December 5, 1913).
7. Two British destroyers.

The total number of vessels in the mercantile marine fitted and to be fitted with this system of propulsion is now in excess of 40. The Cunard Line has two large vessels for intermediate service in hand, the machinery of which will drive twin screws and each be capable of developing 10,000 shaft horsepower. John Brown & Company, Clydebank, has in hand a large vessel for the Orient Line which will have a machinery installation of 12,500 shaft horsepower. This vessel is being built for mail service between London and Australia, and direct comparisons can be made between the performance of the machinery with sister ships having twin screw reciprocating engines and also one having a triple screw combination arrangement of twin reciprocating engines working in conjunction with a low-pressure turbine. The Anchor Line has a large vessel under construction for

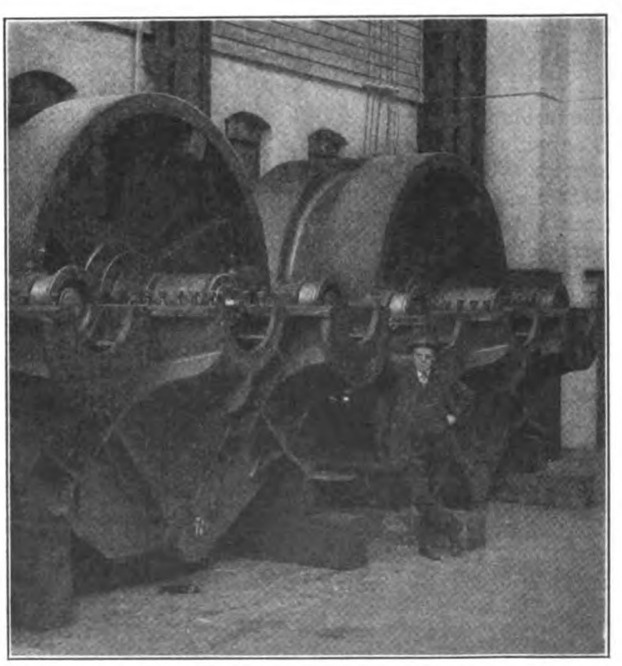

Fig. 3.—Gear Wheels and Pinions Assembled in Casings

* Member Institution of Naval Architects and Society of Naval Architects and Marine Engineers.

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passenger and freight business between Glasgow and New York. This vessel will be driven by twin screws, and the turbines and gearing are designed to develop 8,000 shaft horsepower under service conditions. Two vessels are under construction on the Clyde for the Canadian Pacific Railway Company, the machinery in each case being designed for 12,000 shaft horsepower, while the South Eastern and Chatham Railway Company has a high-power geared turbine vessel for mail service between Dover and Calais.

Among others may be mentioned the following:

One cargo boat of 3,600 shaft horsepower of the Brocklebank Line.

One cargo boat of 900 shaft horsepower of Ruys & Company, Holland.

Two vessels of 5,000 shaft horsepower of the Argentine Navigation Company.

Two vessels of 6,000 shaft horsepower of the Nippon Yusen Kaisha Company.

Five ocean-going vessels of the Federal Steam Navigation Company.

Two ocean-going vessels of the Austrian-Lloyd Company.

One ocean-going vessel of the Union Steamship Company, New Zealand.

One passenger steamboat of 2,000 shaft horsepower, building by A. & J. Inglis, and a lighthouse tender.

Fifty-eight war vessels of various types fitted with all-geared or part-geared turbine installations, two of which have all-geared turbine installations in excess of 30,000 shaft horsepower each.

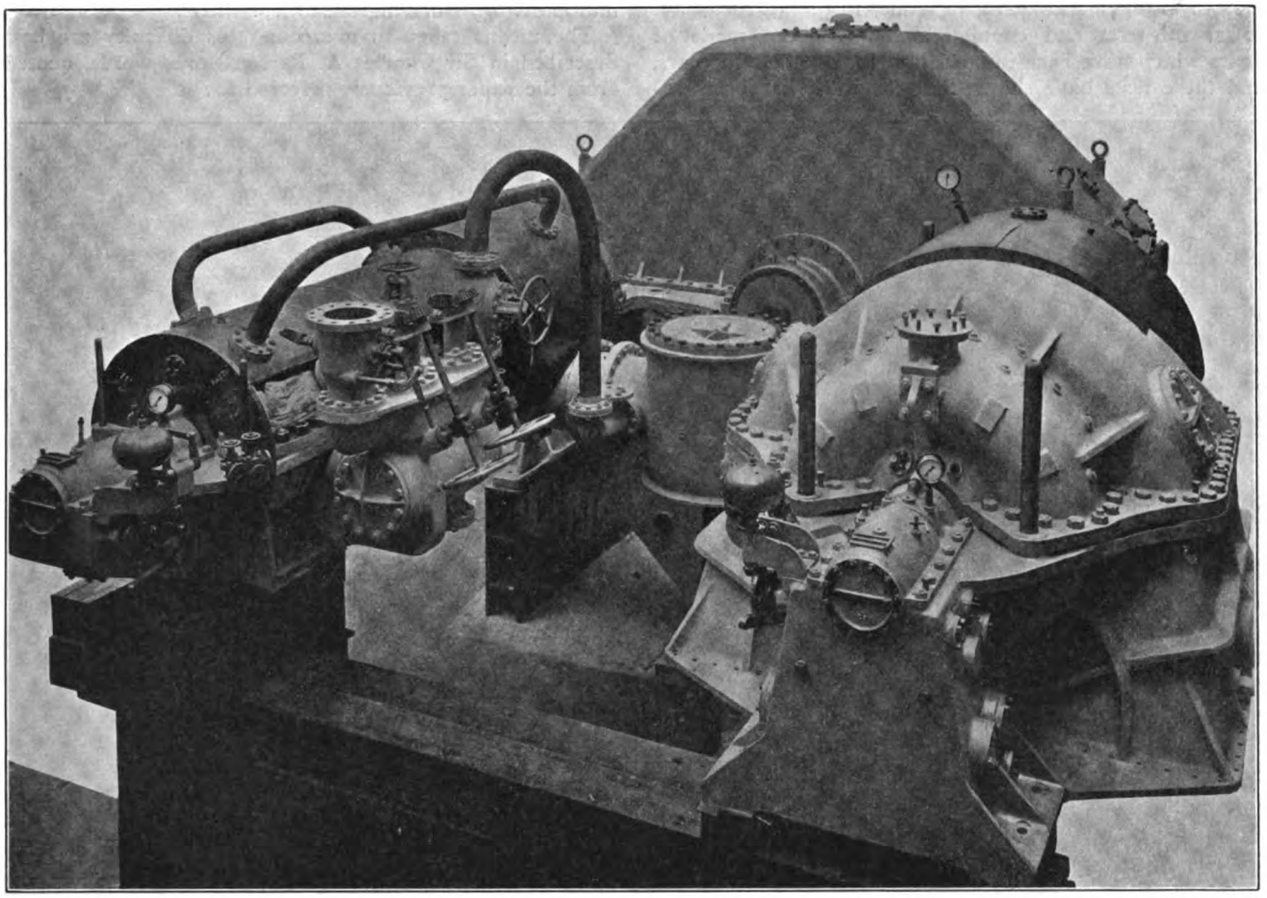

Fig. 4.—High and Low-Pressure Turbines and Reduction Gear Assembled. Astern Turbine Incorporated with Low-Pressure Ahead Turbine

General Design

The following illustrations show the general design of gearing under construction at the present time at the works of The Parsons Marine Steam Turbine Company, Ltd., Wallsend-on-Tyne:

Fig. 1 shows a finished gear wheel and pinion. The approximate diameter of the wheel is 132 inches, and the approximate diameter of the pinion 8 inches, the ratio of reduction being 16.50 to 1. On a vessel fitted with the standard arrangement, a similar pinion is arranged diametrically opposite, the high-pressure ahead turbine driving one pinion and a combined low-pressure ahead and astern turbine driving the other pinion, both pinions being in mesh with the gear wheel.

Fig. 2 shows two sets of gear wheels assembled. One is finished while the other is ready for cutting the teeth in the hobbing machine.

Fig. 3 shows the gears and pinions assembled in a gear case for a merchant vessel, the gear case cover being removed. The turbines are bolted to the facings of the brackets arranged on each side of the lower half of the gear case, and the flanged couplings to which the turbine rotors are bolted are clearly shown in the illustration.

Fig. 4 shows the assembled turbines and gearing. The high-pressure ahead turbine with maneuvering valves is shown at the left bolted to the lower half of the cylinder casing. The combined low-pressure ahead and astern turbine are in one casing on the right. The condenser is placed under this turbine, the flange and bolt holes of the exhaust nozzle being clearly shown in the illustration.

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The gears shown in the foregoing illustrations have been designed by Sir Charles A. Parsons, and the teeth have been cut on a hobbing machine, fitted with his latest invention, commonly referred to as the "creep" mechanism. Full details describing this invention and the experiments connected with its design were published in his paper on "Mechanical Gearing for the Propulsion of Ships" read before the Institution of Naval Architects, 1913, an abstract of which was published in INTERNATIONAL MARINE ENGINEERING, June, 1913.

Careful tests and examinations have been made of gears which have been in operation for one or two years, and these tests have shown that the work has been distributed over the faces of the teeth fairly uniformly, and practically no wear can be detected in the teeth of either the gear wheel or pinions. In practice, however, experience has shown that the gears have been responsible for a certain amount of noise, although it has never been objectionable enough for passengers to make complaints, even in the boats on all-night routes, but it was evident that the art of cutting fast running gears had not been perfected. Sir Charles A. Parsons and his colleagues realized that mechanical means would not entirely overcome this difficulty, and that the only true method to provide silent running gearing is in having a very high degree of accuracy in cutting the teeth.

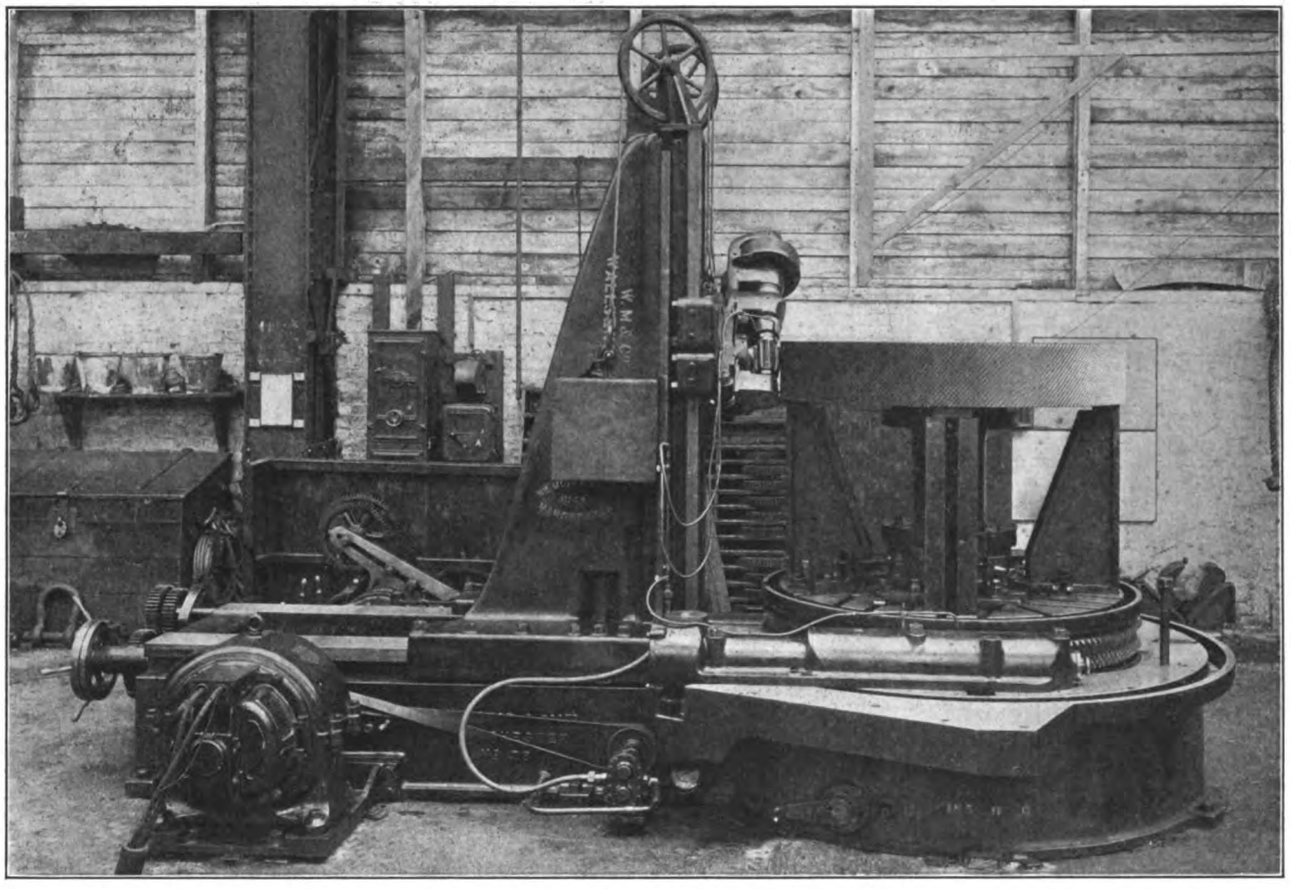

Fig. 5.—Type of Machine Ordinarily Adopted for Cutting Teeth on Reduction Gear

GEAR CUTTING MACHINE

Fig. 5 shows an illustration of the type of machine ordinarily adopted for cutting the teeth, in which the work is mounted on a table rotated by means of a worm and worm wheel and to which the gear wheel is permanently attached during the process of cutting. This machine has been in use for upwards of three years, and upon which gear wheels have been cut amounting to a total of 100,000 horsepower.

The explanation for the noise produced in the gears cut on this machine was traced to the parent gear, and it was found to be due to very slight inaccuracies in the teeth, for which the worm and worm wheel drive were responsible. At the present time it is doubtful if a higher degree of accuracy in cutting can be relied on than in the case of this machine, unless by the introduction of multiple worms driving one worm wheel.

The means taken to overcome this difficulty are best described in Sir Charles A. Parsons' own words, quoted from the paper previously referred to:

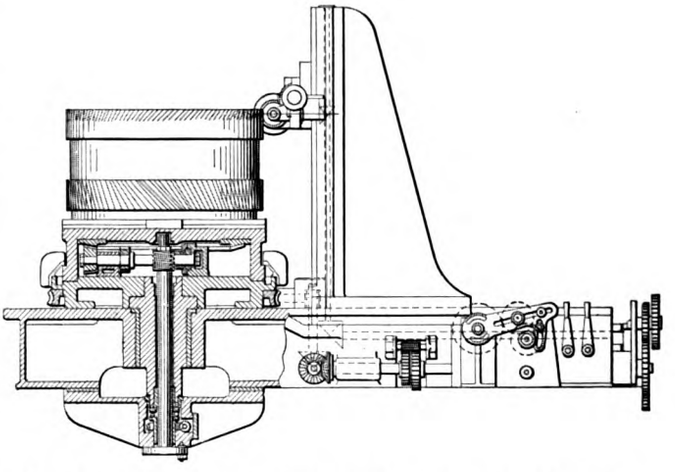

Fig. 6.—Secondary Table Mounted on Original Table of Gear Cutting Machine and Train of Gearing to Give 5 Percent "Creep"

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"It will be seen that in the process ordinarily adopted, in which the work is mounted on a table rotated by means of a worm and worm wheel, the latter being attached permanently to the table, the errors will be some function of the angular position of the work, and, therefore, lie in planes through the axis of rotation; and if, as is mostly the case, the errors of the parent gear are periodic, these planes will lie at equal angular intervals, and will come into mesh periodically. Now, it will be seen that if the work is given a small steady advance in relation to the table, the errors, instead of lying in planes through the axis, will lie in spirals around the wheel, and that when put to work they will be obliterated and leave a true wheel.

"Fig. 6 is an illustration of the adaptation of this new principle of cutting to an existing gear hobbing machine. A secondary table is mounted on the original table of the machine and given a creep in advance of 5 percent in relation to it by means of the train of gearing shown, the main worm driving the lower table being driven at 5 percent less speed, so as to secure the same rotational speed as before the creep was introduced.

"While the most important effect of this arrangement is that the errors in the teeth will lie in very oblique spirals around the wheel, resulting in great uniformity in the gearing, at the same time it has also an important effect in reducing the errors themselves."

This article has been written for the purpose of bringing to the notice of ship-owners, shipbuilders and engineers the large amount of marine mechanical gearing which is under construction in Great Britain at this time, the engines of which will drive vessels across the North Atlantic and all over the world by means of steam turbines and mechanical gearing.

Advantages of Geared Turbine Drive

The following advantages have been clearly demonstrated for this new method of ship propulsion, when compared with reciprocating engine machinery:

1. Economy in fuel consumption, varying from 10 to 25 percent, dependent on the type of vessel under consideration.
2. Saving in the machinery weights varying from 10 to 20 percent.
3. Saving in engine room space for large ocean-going vessels.
4. Less liability for broken line shafting, due to the even turning moment of turbine machinery.
5. In a single screw vessel, with the ahead turbines of the reaction type arranged in series, either turbine can be used independently of the other, so that this lessens very greatly any chances of a complete breakdown of the main propelling machinery.
6. Splendid economy of steam consumption is obtained in the reaction type of turbine with moderate boiler pressures, varying from 150 to 175 pounds working pressures, with its consequent advantages of a lighter and safer machinery installation.

Finally, there does not appear to be any limit to the horsepower that can be transmitted through gearing suitably designed for any proposed work.

New Revenue Cutters to be Built at Newport News.—The Newport News Shipbuilding and Dry Dock Company, Newport News, Va., has been awarded the contract to build the two new revenue cutters, bids for which were opened by the Treasury Department on September 1. The successful bid was $396,000 (£81,250) for the two ships, the work to be completed in ten months.

The Determination of Dimensions for Cargo Ships

BY THOMAS GRAHAM, B. SC.

During recent years a large amount of attention has been directed toward the forms of cargo vessels. To a certain extent this has made the determination of actual shape a much easier task than formerly, but it has not placed in the hands of the naval architect a ready and practical method of fixing the dimensions of ships. The determination of dimensions is the first and most important duty of the designer—and certainly it is the most difficult. In many instances the shipowner merely states the deadweight he wishes his new vessel to carry, the speed at which it must be carried and the limiting drafts of the harbors in which the vessel will trade. Now to fix dimensions on so practical an enumeration of requisites always presents a difficulty, no matter how adequate may be the data of previous ships in the possession of the naval architect. And the difficulty exists, not from the lack of information so much as from an absence of some satisfactory method of reducing the "dimension-determining" results to a common rule or formula of application. For instance, if designs are invited for a proposed new ship, the natural procedure is to refer first of all to ships actually built and pick out the one conforming most accurately to the new requirements. Sometimes this may suggest the exact dimensions, but most frequently it only provides an inadequate approximation followed by a process of trial and error, involving calculations of weights, trim and stability until the appropriate figures are obtained.

Now in cargo vessels where, within limits, there does exist much similarity of form and speed, it should not be impossible to establish some empirical formula having an application more or less general to all ships of this kind.

For instance, the identity—

hull weight + machinery weight + deadweight = displacement.

might be wholly expressed in terms of the linear dimensions. Further, two of these dimensions, such as length and depth, might be resolved into terms of the third, breadth, and then the equation would become a function of breadth, and with this determined, experience of ship's proportions could readily infer the length and depth. Returning to the above equation, the hull weight for a finished ship is always expressed as a coefficient of the block number for purposes of comparison with other vessels.

Where C_h is a coefficient hull weight $= C_h \times L \times B \times D$. (1)

But it might be pointed out here that however common and natural a basis of comparison this coefficient may be, it is highly unsatisfactory. Depth for one thing is too fluctuating a measure to introduce into a general formula. It is no uncommon thing to have two ships identical in length, breadth and weight and virtually the same depth, and yet according to this conventional method of comparison, the hull coefficients may be entirely at variance. For instance, a flush shelter deck steamer and a poop, long bridge and forecastle deck steamer might be exactly the same length and breadth and of the same hull weight, and yet on account of the different reckoning of depth the latter type of ship would possess a much higher hull coefficient than the former. In this way, unless vessels are grouped into exactly similar types, the hull coefficient is a precarious and inadequate figure of comparison.

If, however, we take the expression $C_h \times L \times B \times D$ and express it entirely in terms of the breadth, it becomes

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$K_h \times B^3$. Here the factor of depth is eliminated altogether because its presence in C_h is canceled by its proportion in B.

Now K_h seems to be a comparatively uniform figure, and Fig. 1 shows values of it plotted on an abscissa of $\frac{L}{B}$ from 7 to 8.5. It will be noticed that the variation of K_h is very small, namely, from .02 to .03 over a range of $\frac{L}{B}$, which embodies nearly every type and size of cargo vessel,

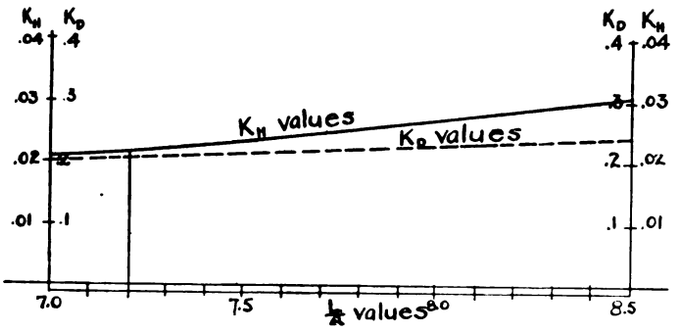

Fig. 1

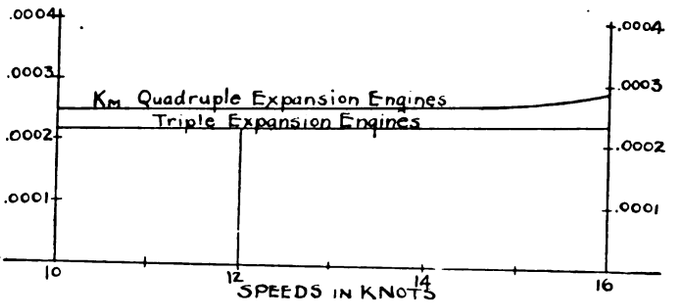

Fig. 2

and this small variation renders K_h most accurate for preliminary work.

In regard to the machinery weight, this is usually expressed as a coefficient of the horsepower of the ship.

Weight of machinery $= C_m \times I.H.P.$, and for our particular purpose the right-hand side of the equation has to be expressed in terms of the linear dimensions.

$$I.H.P. = \frac{(\text{Displacement})^{2/3}\,(\text{Speed})^3}{\text{Constant}} = \frac{D^{2/3} \times V^3}{C}$$

$$I.H.P. = \frac{\left(\frac{L \times B \times d \times b}{35}\right)^{2/3} V^3}{C} = \frac{(L \times B)^{2/3} \times d^{2/3} \times b^{2/3} \times V^3}{(35)^{2/3} C}$$

$$I.H.P. = K_m \times B^{4/3} \times d^{2/3} \times b^{2/3} \times V^3 \qquad (2)$$

where d = draft, b = block coefficient and V = speed in knots. Now these last three items are always known initially, so that the numerical part of expression (2) other than K_m, is determined at once.

Fig. 2 shows K_m values on an abscissa of speeds ranging from 10 to 16 knots. The values are divided into two classes, one for quadruple expansion and the other for triple expansion engines. It will be borne in mind, of course, that the curves here plotted are empirical and the results of many ships may show divergence from them, but any such divergence is not likely to be of a grave nature, so that, as in the case of K_h values, they will be found to have a remarkably accurate application.

$$\text{Displacement itself} = \frac{L \times B \times d \times b}{35} = d \times b \times K_d \times B^2 \qquad (3)$$

Values of K_d are given in Fig. 1 along with the K_h values. The resultant equation for dimensions then becomes:

$$K_h \times B^3 + d^{2/3} \times b^{2/3} \times V^3 \times K_m \times B^{4/3} + \text{Deadweight} = d \times b \times K_d \times B^2 \qquad (4)$$

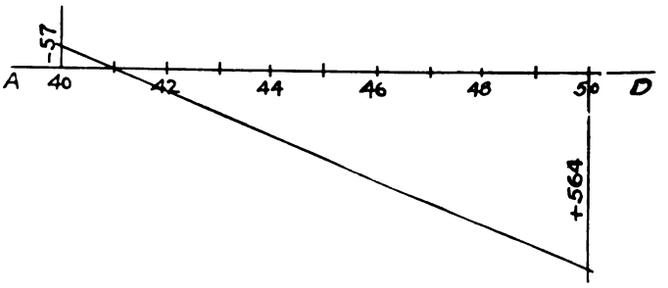

Fig. 3

Table I gives a sample catalogue of d, b and V values with their corresponding power values employed in the above equation.

Now, although equation (4) appears lengthy and complicated, such an expression only arises from the general way in which it is expressed. Every value in it except B is numerical, and B itself is determined in a simple graphical manner.

TABLE I

V	V^3	d^2	$d^{2/3}$	b	$b^{2/3}$
10	1,000	12 feet	5.24	.66	.759
10½	1,158	13 "	5.53	.67	.766
11	1,331	14 "	5.81	.68	.773
11½	1,521	15 "	6.08	.69	.780
12	1,728	16 "	6.34	.70	.787

A fully worked example will illustrate the procedure and application of the formulæ. A shipowner desires a new ship to carry a total deadweight of 2,000 tons at a speed of 12 knots on a load draft of 16 feet.

Assume first a block coefficient, say .69, and second a proportion of length to breadth, say 7.2; these, of course, requiring the judgment and experience of the designer.

Suppose also the vessel to have triple expansion engines.

Equation of dimensions:

$$K_h \times B^3 + d^{2/3} \times b^{2/3} \times V^3 \times K_m \times B^{4/3} + 2{,}000 = d \times b \times K_d \times B^2$$

From curves:

$K_h = .0218.$
$K_m = .000225.$
$K_d = .204.$

and from Table I:

$d^{2/3} = 6.34.$
$b^{2/3} = .780.$
$V^3 = 1728.$

Therefore the equation becomes:

$$.0218\,B^3 + (6.34 \times .78 \times 12^3 \times .000225)\,B^{4/3} + 2000 = 16 \times .69 \times .204\,B^2$$

$$.0218\,B^3 + 1.925\,B^{4/3} - 2.252\,B^2 = -2000.$$

Assume any figure for B, say 50, and substitute it in the equation.

The result is + 564.

Give any other value to B, say 40, and substitute again, when the result will be — 57.

It will be seen from this that B lies somewhere between 40 and 50 feet.

To determine B exactly, draw a line A-D and mark off

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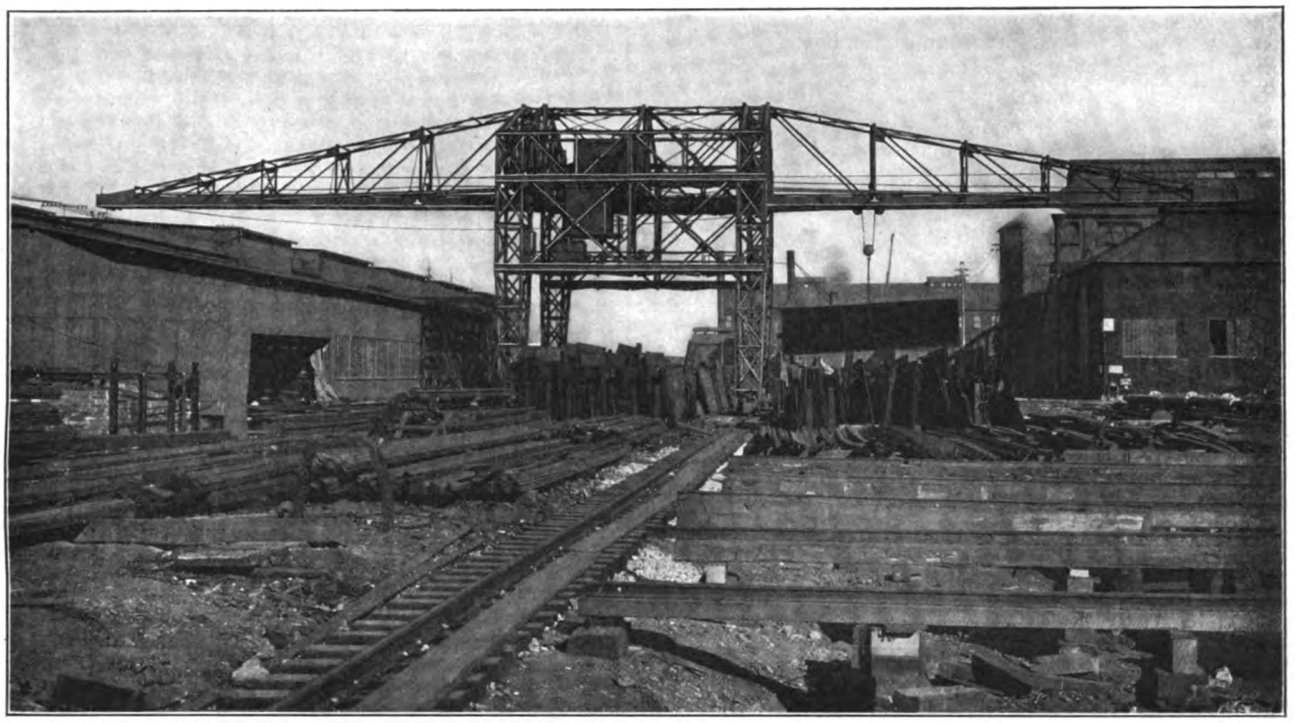
10 equal divisions on it. Call the first division 40 and the tenth division 50. Erect perpendiculars at these extremities as shown in Fig. 3, and mark off 57 and 564 units on opposite sides of *A-D*. Join the points so marked off and where the joining line cuts *A-D* is the appropriate value of *B*.

In the example, the appropriate breadth of vessel required is 41 feet and the length will be $7.2 \times 41 = 295$ feet.

If the vessel be of the flush, "three-deck" type, a suitable depth would be .73 times the beam = 30 feet.

The required dimensions then are: 295 feet × 41 feet × 30 feet to upper deck.

The trim, stability and capacities can now be verified and any slight discrepancy in the dimensions which these calculations may detect will, of course, be adjusted.



Double Cantilever Electric Traveling Gantry Crane, Installed in the Yards of the Union Iron Works, San Francisco, Cal.

Steel Storage in Shipyards

The convenient storage of the various classes of structural shapes and plates required for modern shipbuilding presents an unusual problem in efficient handling and transportation. In a large shipyard the storage must necessarily involve a large and constantly changing tonnage and cover a considerable area, and the material must be stocked in such a manner as to be readily accessible, this latter being a prime requisite.

The accompanying illustration shows a double cantilever electric traveling gantry crane located in the yards of the Union Iron Works Company at San Francisco, Cal. At the time the photograph was taken the "racks" were not all completed, but the general plan of storage is shown and it will be apparent that each classification is readily accessible and without disturbing other material. The storage yard is approximately 750 feet long and 175 feet wide, and is served both by railroad tracks and by the industrial tracks communicating with the adjoining fabricating shops.

This crane was built by the Shaw Electric Crane Company, of Muskegon, Mich. (Manning, Maxwell & Moore, Inc.). Its normal capacity is 3½ tons and the lift or hook travel 27 feet 6 inches. The span or distance from center to center of the rails is 33 feet. With a cantilever extension of 67 feet 6 inches on either side the overall length of the bridge amounts to 168 feet, giving an effective cross travel of the hook of 160 feet. The hoisting speed at full load is 60 feet per minute, the trolley speed at full load 300 feet per minute, and the bridge speed at full load 400 feet per minute.

The gantry structure is carried on eight wheels with four equalizing trucks, and the clear opening between the gantry legs is 30 feet, so that large plates can be handled without swiveling or interference. All three motions are controlled from the cage, located near the center of the trolley travel, where the operator has an unobstructed view of the entire storage. The plates are handled by grip-tongs and bundles of shapes by chain slings. It is reported that this crane effects a saving of eight men, but it is obvious that this statement is by no means the final measure of the economy, as the saving in time is probably fully as important a factor.

The Triple Screw Liner Statendam

The history of the Holland-America Line is a record of uninterrupted progress and development, and the launch of the triple screw passenger and mail steamer *Statendam*, which took place early in July, signalizes an even greater advance than anything previously recorded, the new vessel being nearly 770 feet in length overall, and over 86 feet beam, with a gross tonnage exceeding 33,000 and a displacement of 44,000 tons. The *Statendam* has been built to the highest class at Lloyds by Messrs. Harland & Wolff, Ltd., of Belfast, under survey of the British Board of Trade for passenger certificate and also to meet the requirements of the Dutch and American laws. The structure of the hull is exceedingly strong. The double bottom extends right fore and aft and there are eleven watertight bulkheads carried up to the bridge deck at the fore

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part of the vessel and the saloon deck at the after part. There are 9 steel decks. The vessel has 3 funnels and 2 steel pole masts fore and aft schooner rigged, 4 derrick posts, 25 steel derricks, electric winches and Harland & Wolff steam steering gear, controlled by telemotor from the navigating bridge. A complete installation of electric light, also emergency lighting and wireless telegraphy and submarine signaling outfit, is also provided. The arrangements generally for working the ship and cargo will be of the most complete character.

The passenger accommodation provides for over 3,000 people, distributed into 800 first class, 630 second and nearly 2,000 third class. The first class passengers will be accommodated in one-berth, two-berth and three-berth rooms, the second class in two- and four-berth rooms. The first class public rooms include a dining saloon on the saloon deck, reading and writing room, lounge and palm court, smoke room and verandah, all on the upper promenade deck, and a gymnasium on the boat deck. The forward stairway has two passenger elevators serving six decks. The first class staterooms include thirty-two *en suite* rooms on the lower promenade deck, the other staterooms being arranged on the upper, saloon, bridge and lower promenade decks. Many of the first class staterooms are arranged on the tandem principle, securing natural light and ventilation to each. At the after end of the first class accommodation on the bridge deck a maids' and valets' dining room is arranged. The second class public rooms include dining saloon, smoke room and library, and the second class staterooms are arranged on the saloon, upper and middle decks. The third class passengers have a general room and smoke room on the saloon deck aft and a smoke room on the same deck forward. The third class messrooms are large, comfortable apartments on the middle deck. The third class sleeping accommodation includes a large number of permanent and portable rooms.

The captain's and officers' accommodation is in a deck house at the forward end of the boat deck. The engineers' are situated on the port side of the upper deck, convenient to the engine room. The chief steward's office will be placed at the main entrance of the bridge deck port side and the purser's office at the starboard side. The pantry and galley arrangements have been carefully devised to insure the best possible service. The vessel is provided with refrigerating machinery and refrigerated storerooms. The emergency lighting set, consisting of a Diesel engine and dynamo, is arranged in a steel house at the after end of the saloon deck with storage tanks on the bridge deck overhead. Boats are provided sufficient for all on board.

It will thus be seen that the *Statendam* will be complete in every respect, representing the highest attainments in naval architecture. In marine engineering also the vessel will embody the most recent advances, being, as already indicated, a triple screw steamer having a combination of the most highly perfected reciprocating engines with a low-pressure turbine.

MONTHLY SHIPBUILDING RETURNS.—Eighty vessels aggregating 21,477 gross tons built in the United States were officially numbered by the Bureau of Navigation, Department of Commerce, during the month of August. Steel steamships comprised 64 percent of this tonnage. In addition, two foreign-built steel steamships—the *Oceana*, of 7,796 gross tons, built at Dumbarton, and the *Moldegaard*, of 2,852 gross tons, built at Bergen, Norway—were admitted to the American registry under the Act of August 18.

The Cummings Engine Log System

Taking advantage of the uniform slip of propellers at any given speed of the vessel, Henry H. Cummings has developed instruments that automatically transfer the revolutions of the propellers into the distance traveled through the water. These instruments automatically compute accurately the distance traveled every hundred revolutions of the main engines and the revolutions per minute every two hundred revolutions of the main engines.

The system is operated by means of the vacuum in the condensers in such a way that connection between the condenser and the instruments is made every hundred revolutions of the main engines. An indicator pump, run from each propeller shaft, a direction indicator for each shaft, course counters and averaging counters, stop clocks and engine logs, together with connections, comprise the

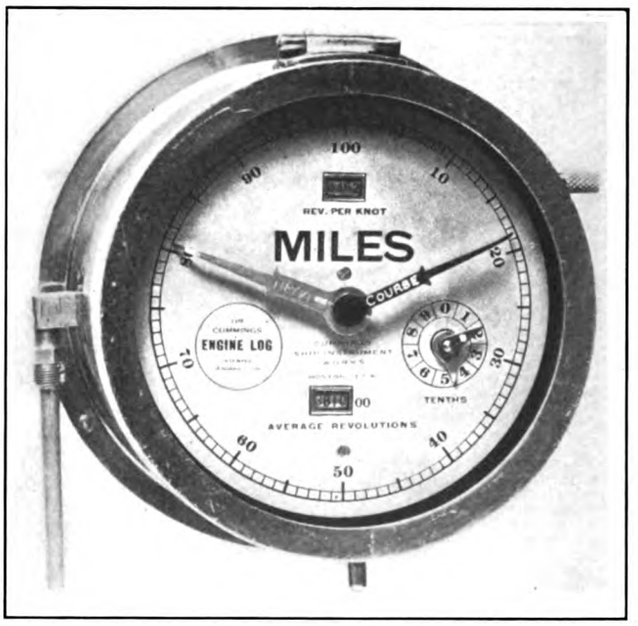

Fig. 1.—Engine Log

essential parts of the installation in full. The averaging counters give automatically and continuously the exact average of revolutions for the various propellers. To comply at the same time with naval requirements, which call for a continuous rotary counter, showing the total revolutions made by the engines, both ahead and astern, the connections to the averaging counter are provided with a "one-way gear," which runs the counter forward regardless of the direction of rotation of the shafts. It is claimed that the use of gears in the averaging instruments does away with the errors inseparable from other methods of driving these counters. In addition to the averaging counters, this instrument, which is in the engine room, carries a dial for the revolutions per minute, operated by means of a knurled handle at the left. By keeping the teeth in contact for thirty seconds by the watch the record of revolutions per minute is shown. If more accurate results are required, or it is desired to reduce the personal error in reading the watch, another gear may be thrown in and the reading taken for five minutes, giving the average revolutions per minute over that period. This device permits the engineers to check up the revolutions per minute, independently of the instruments on the bridge.

The direction indicators are operated by means of pressure or vacuum produced by a small pump connected to

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each shaft. For rotation in one direction the vanes within the pump produce a partial vacuum, resulting in throwing the pointer into the "ahead" position. When the direction of rotation of the shaft is reversed, the vanes of the pump produce a definite pressure within the pipe leading to the indicator, thus throwing the pointer into the "astern" position. As soon as the shaft comes to rest the pointer returns to zero.

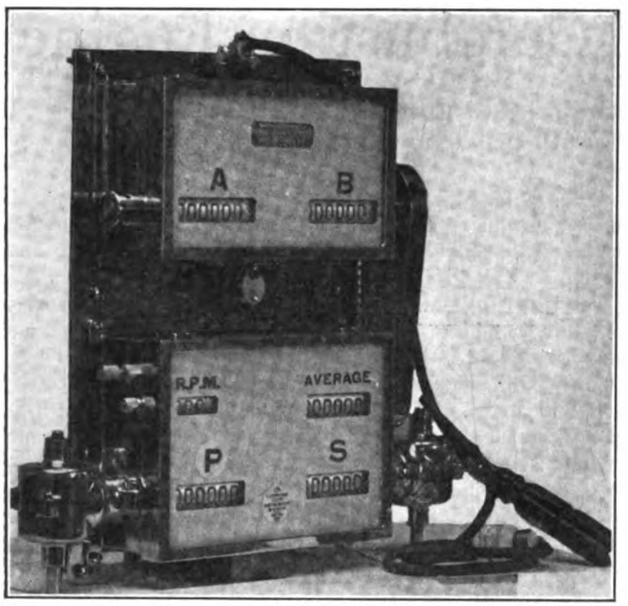

Fig. 2.—Two-Shaft Averaging Counter with "Course Counter" Above

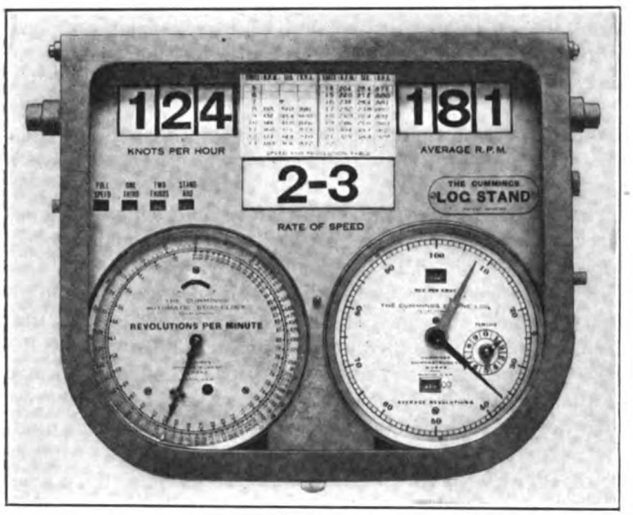

Fig. 4.—Log Stand for the Bridge

The mechanism of the stop clock is similar to that of an ordinary stop watch. The vacuum in the connecting pipe drops the piston, thereby starting the hand. The vacuum in the pipe is broken when the rotary valve shuts off the condenser connection, air then being admitted to the pipe and the piston returned by a spring. As soon as the engines make one hundred revolutions from the time of starting the clock, the pipe again opens to the condenser, the piston descends and stops the clock. The hand remains for several seconds at the point where it was stopped before being released and returned automatically to zero. The cycle is repeated every two hundred revolutions, one hundred being consumed in the motion of the hand and one hundred in its reading and recovery. An auxiliary dial around the circumference of the main dial on the stop clock is graduated in knots speed to fit each particular ship.

The counter in the engine log moves up one unit for every hundred revolutions of the engines, and two ciphers on the dial complete the reading. The log has a small opening at the top of the dial reading "revolution per

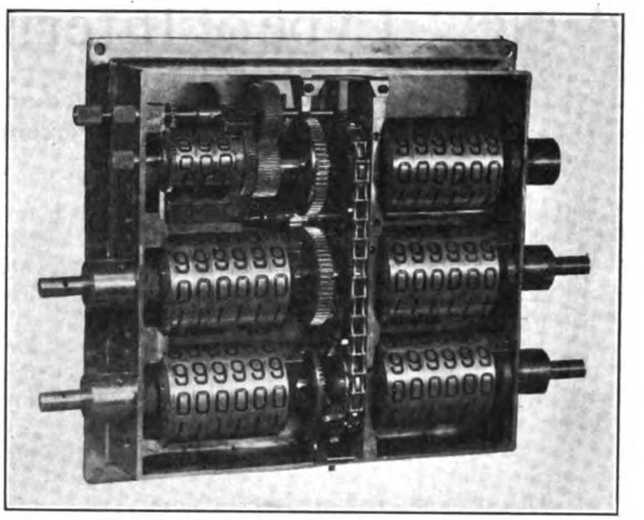

Fig. 3.—Mechanism of Four-Shaft Averaging Counter

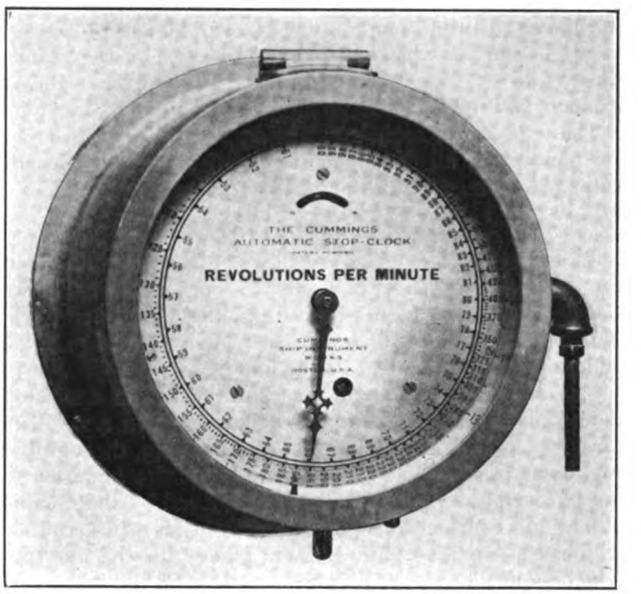

Fig. 5.—Stop Clock

knot," showing the revolutions required to make one nautical mile through the water at the desired speed. This figure may be changed, as the speed changes by means of a knurled knob on the right of the indicator. The engine log also has an auxiliary hand which is carried by friction upon the shaft of the main hand. This hand, which is labeled "course," may be set at zero upon passing a buoy or mark and will thus register the distance covered from any desired point. The accuracy of this instrument is, of course, dependent upon the navigator's ability to estimate the revolutions required per mile.

The auxiliary or course counter, above the averaging counters and usually in one engine room only, practically

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completes the full installation. This counter, designed particularly for standardization of the propellers and for trial runs, contains two counting cylinders, and these are operated individually from the averaging counter below, one cylinder running while the other is stationary. This shows accurately the total "averaged" number of revolutions for a given time or over a given distance, and is operated or thrown in and out of action by an electrical circuit breaker from the bridge or any convenient place.

This apparatus is manufactured by the Cummings Ship Instrument Works, Boston, Mass.

A New Type of Internal Combustion Engine*

Two Two-Stroke Pistons Combined on Each Crank—Increased Power Developed for a Given Weight—Thirty Percent Overall Efficiency Obtained on Test

BY H. F. FULLAGAR, M.A.

Three fundamental factors are chiefly responsible for the difficulties in the construction of internal combustion engines of existing types; difficulties which increase with the size of the unit and ultimately limit the power which can commercially be built. These factors are:

(*a*) That the heat per unit of surface radiated by the flame to the cylinder walls increases with the size of the cylinder, while the thickness of metal through which this heat has to reach the cooling water also increases.

(*b*) That the weight per horsepower increases with the size of the cylinder.

(*c*) That useless forces are called into play; useless in that they are either stationary and do no work, or even produce negative work. These result from (1) the fluid pressure on the cylinder covers, which has to be transmitted through the framing of the engine; (2) the negative work of the compression stroke, which in single-acting engines produces a reversal of twist in the crankshaft; and (3) the inertia forces resulting from want of balance and imperfect cushioning.

The type of internal combustion engine described below eliminates all these factors, and has besides the advantages of mechanical simplicity and accessibility.

Description of System

The construction which is shown diagrammatically in Fig. 1 consists in using as a unit two open-ended cylinders side by side, each with two pistons, and rigidly connecting the pistons *A* to *D*, and *C* to *B*, by means of pairs of oblique rods, external to the cylinders.

The action of the engine is as follows: An explosion taking place between *A* and *B* drives *B* down and *A* up, drawing up *D* by the oblique rods, and giving, through the two connecting rods, two equal and opposite impulses to the two cranks. The side thrust produced by the oblique pull is, of course, taken by the crossheads of *A* and *D*, which are provided with suitable guides for the purpose. The obliquity of the rods is small, less than the maximum obliquity of the connecting rods, so that the friction is actually less than would be the case if each piston had its own crank and connecting rod, and the mechanical efficiency of the engine is high.

At the ends of their strokes, the pistons uncover inlet and exhaust ports in the cylinder walls, as in the Oechelhauser arrangement. The engine works on the "two-stroke cycle," and each crank receives, therefore, two impulses per revolution. Air is supplied to the cylinders by low-pressure air pumps, which can be driven from the engine by side levers in the ordinary way. In engines of the light high-speed types, for submarine and such purposes the upper crossheads and guides are formed to act as air pumps, and effect a further saving in space and weight.

Engines for stationary purposes will usually comprise two units, making four cylinders. For very large powers or when height is limited, as, for instance, in submarines, engines will comprise six or even eight cylinders.

It will at once be clear that with this construction useless forces are avoided or greatly reduced. There are no cylinder covers, or, in fact, any high-pressure joints in the engine. There are no vertical stresses on the framing of the engine at all. The pressure of the explosion is entirely taken between the steel parts, shown in Fig. 2, the crosshead, oblique rods, connecting rods and crankshaft; and only the secondary reactions of the slippers, from one-fifth to one-twentieth of the explosion forces, reach in a horizontal direction the framing of the engine.

The fluid pressure in each cylinder acts at every moment equally on the two cranks. The main bearings are thus relieved of practically all load, except for the weight of the parts, which, acting vertically, is just sufficient to keep the bearings in constant thrust.

The action of the explosion in driving apart the pistons *A* and *B* draws together, by means of the oblique rods, the pistons *C* and *D*, compressing the charge between them, so that the negative work of compression is performed, not through the crank and connecting rods, but directly through the oblique rods, and only the net useful work is transmitted to the crankshaft.

The reciprocating parts are cushioned at each end of every stroke, Fig. 3. This follows from the fact that each stroke includes a compression and explosion. On the upstroke, the pistons *A* and *D*, for instance, are cushioned by the pressure on *D*, and on the downstroke by the pressure on *A*. The combined effect of inertia and cushioning is to keep the oblique rods, except in the case of very small engines, in constant tension.

The effect of inertia is also to make the crank effort much more uniform. When an explosion occurs between, say, *A* and *B*, the force reaching the gudgeon pin of *B* is less than the explosive pressure on *B*, by the inertia of the connected pistons *B* and *C* with their crossheads and oblique rods, whose acceleration is at that moment at a maximum. The cost of an engine is largely determined by the maximum pressure to which its cranks are subjected, but it is the mean-effective-pressure which determines its useful output, and the nearer the maximum is to the mean, the lighter and cheaper the engine.

In single-acting engines, whether of the simple, tandem or Oechelhauser type, the explosion and compression strokes twist the crankshaft alternately in opposite directions, Fig. 4, producing a severe condition of stress, but, with the new construction, each connecting rod is double

* A paper read at the joint summer meeting of the Institution of Naval Architects, Institute of Engineers and Shipbuilders in Scotland, and Northeast Coast Institution of Engineers and Shipbuilders, at Newcastle-upon-Tyne, July, 1914.

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acting, and the effort of each crank uniformly in one direction, Fig. 3. A four-crank engine, therefore, receives four pairs of balanced impulses per revolution, eight in all, so that the turning effort of this engine is unusually uniform.

Balance

The balance which results is practically perfect. The center of gravity of a pair of pistons, *A* and *D*, for instance, is at the point *P*, Fig. 2, and moves up and down on the line *PQ*, while the center of gravity of the other pair is at the point *Q* and moves down and up on the same line. This is probably the only engine in which the centers of gravity of the balancing masses have the same identical locus. Secondary inertia forces are produced by the angularity of the connecting rods, which causes the center of gravity of all four pistons to move up and down, by an amount which is shown in Fig. 5. The complete oscillation occurs twice per revolution, but in a four-cylinder engine with cranks at right angles the center of gravity of the second set of four pistons oscillates the same amount in opposite phase, so even these secondary vertical forces are completely eliminated.

Such then are the working forces in this mechanism. If they be divided into the two rough classes, which for the purpose of this brief description I have called "useful" and "useless" forces, the only ones falling into the latter class are the minor reactions from the slippers at the ends of the oblique rods, constant in direction and less, both in number and amount, than the "useless" reactions of any other reciprocating engine in common use, whether gas or steam.

Weight

As regards weight, the new construction, by combining eight two-stroke pistons with four cranks, produces a given power upon one-half to one-third the weight required with other constructions. The mean-effective-pressure with the two-stroke cycle need not be less than three-quarters of that with the four-stroke cycle. An engine of the new type is therefore equivalent to a four-stroke engine with not less than twelve pistons of the same size. Since larger cylinders are heavier for their power than smaller ones, a four-stroke engine of the same power with fewer cylinders of larger dimensions will be still heavier. Clearly, therefore, the saving in weight of the new construction is very considerable.

From a heat point of view, the double type of cylinder has incomparable advantages over all others, and with the new construction such cylinders require but one crank each. In form the cylinder is a plain tube, supported at either end, but free to expand axially, and surrounded with its fellows by a common tank, forming the water jacket. In such a cylinder, temperature stresses cannot occur. If a tube free to expand be heated symmetrically so that its temperature around each zone is uniform, variation of temperature along the axis of the tube produces no stress whatever. Moreover, in the absence of corners or pockets, the actual mean temperature of the inner surface of the cylinder is very low.

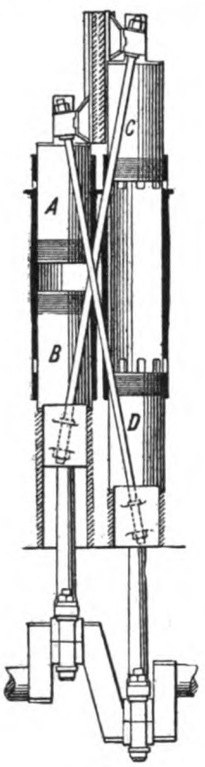

Fig. 1

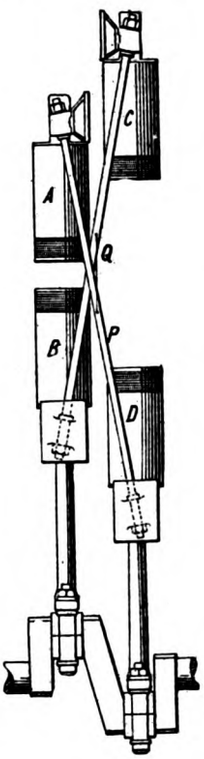

Fig. 2

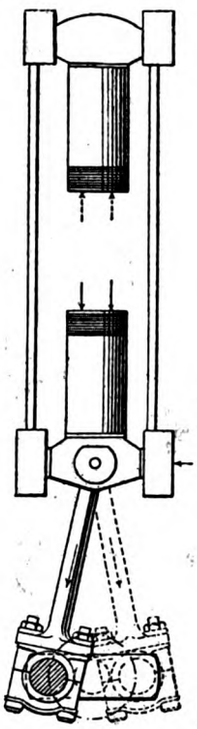
Fig. 3

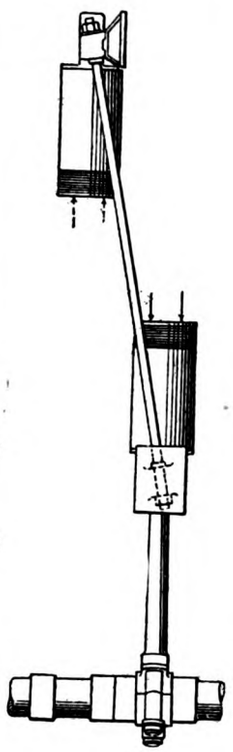
Fig. 4

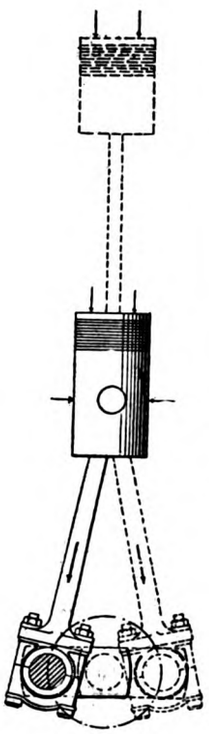
Fig. 5

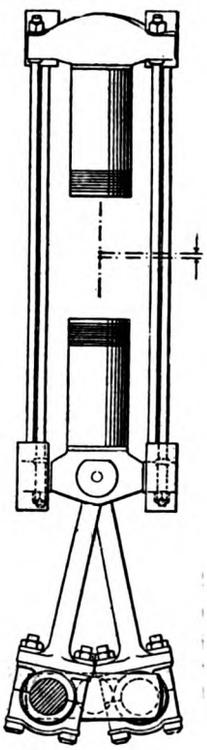
Fig. 6

Demonstration Engine

To test the system on a practical scale, an engine of 500 horsepower was built by Messrs. W. H. Allen, Son & Company, Ltd., of Bedford, to the designs of this company, and installed in the engine room of the Newcastle Electric Supply Company, at Gateshead. The power of the engine is absorbed by an electric generator connected with the Electric Supply Company's mains. The engine, which is of the stationary type and of substantial proportions, weighs without flywheel under 20 tons. It gives continuously some 550 brake horsepower, and its weight is therefore less than half that of gas engines of equal power.

This result is obtained with four cylinders only 12 inches in diameter, with the moderate piston speed of 750 feet

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per minute, with the low mean-effective-pressure of under 70 pounds per square inch, a maximum stress in the steel parts of only four tons per square inch, and a stress in the cast iron portions of the engine nowhere exceeding three-quarters of a ton. The engine, in fact, produces its power upon half the usual weight of material, and with working stresses which, so far from being severe, are in the main appreciably less than exist in reciprocating steam engines.

The normal speed of the engine is 250 revolutions per minute, and even if this is increased to 300 revolutions per minute, the engine is still remarkably free from vibration. The crankshaft normally receives 2,000 separate impulses per minute.

An upper piston can be withdrawn in about ten minutes after stopping the engine, and the lower piston lifted out through the cylinder in five minutes more. The whole of the eight pistons can be withdrawn in an hour, with the use of a hand crane only.

This particular engine is supplied with air and gas by auxiliaries of a somewhat makeshift character, the air by a fan and the gas by a pump. In spite of this, the overall efficiency during a 30-hours' test from heat of gas supplied to brake horsepower was found by Professor Hopkinson to be just under 30 percent, while the indicated efficiency was 37.6 percent, the difference being largely accounted for by the inefficient auxiliaries. The mechanical efficiency of the engine itself is about 90 percent.

Perhaps the chief interest of the system lies in the promise it holds out of much larger powers with fewer parts and lower stresses, applicable to sea-going vessels of all classes. With no inclination to tempt the future by endeavoring to prophesy, I may point out that with gas as fuel and a mean-effective-pressure of under 70 pounds per square inch, it is a matter of arithmetic that a four-cylinder engine to develop 2,400 brake horsepower would require cylinders only 24 inches diameter, and for a 5,000 brake horsepower only 36 inches diameter, while with liquid fuel and a mean-effective-pressure of 115 pounds a diameter of only 24 inches is sufficient for 4,000 brake horsepower.

ANOTHER ST. LAWRENCE COLLISION.—The Black Diamond collier *Lingan* rammed and sank the Government steamship *Montmagny*, with a loss of fourteen lives, during a fog, twenty-six miles from Quebec, in the St. Lawrence River early in the morning of September 18. The *Montmagny* sank within three minutes after the collision, while the collier, although leaking badly, proceeded under her own steam to Quebec.

An Economical Fueling Lighter

In connection with the fleet of self-propelled coal-carrying barges, built recently for the Alabama & New Orleans Transportation Company, a description of which was published in our November, 1913, and August, 1914, issues, there was also built an unusual type of fuel barge for bunkering the steamships at New Orleans. The fueling barge is of the same general design as the coal barges, its dimensions being limited by the size of the Lake Borgne canal locks to a length of 240 feet, a beam of 32 feet and a maximum draft of 7 feet. The general designs for the fueling barge were made by John H. Bernhard, of New Orleans, while the working plans were made by the Great Lakes Engineering Works, Detroit, Mich

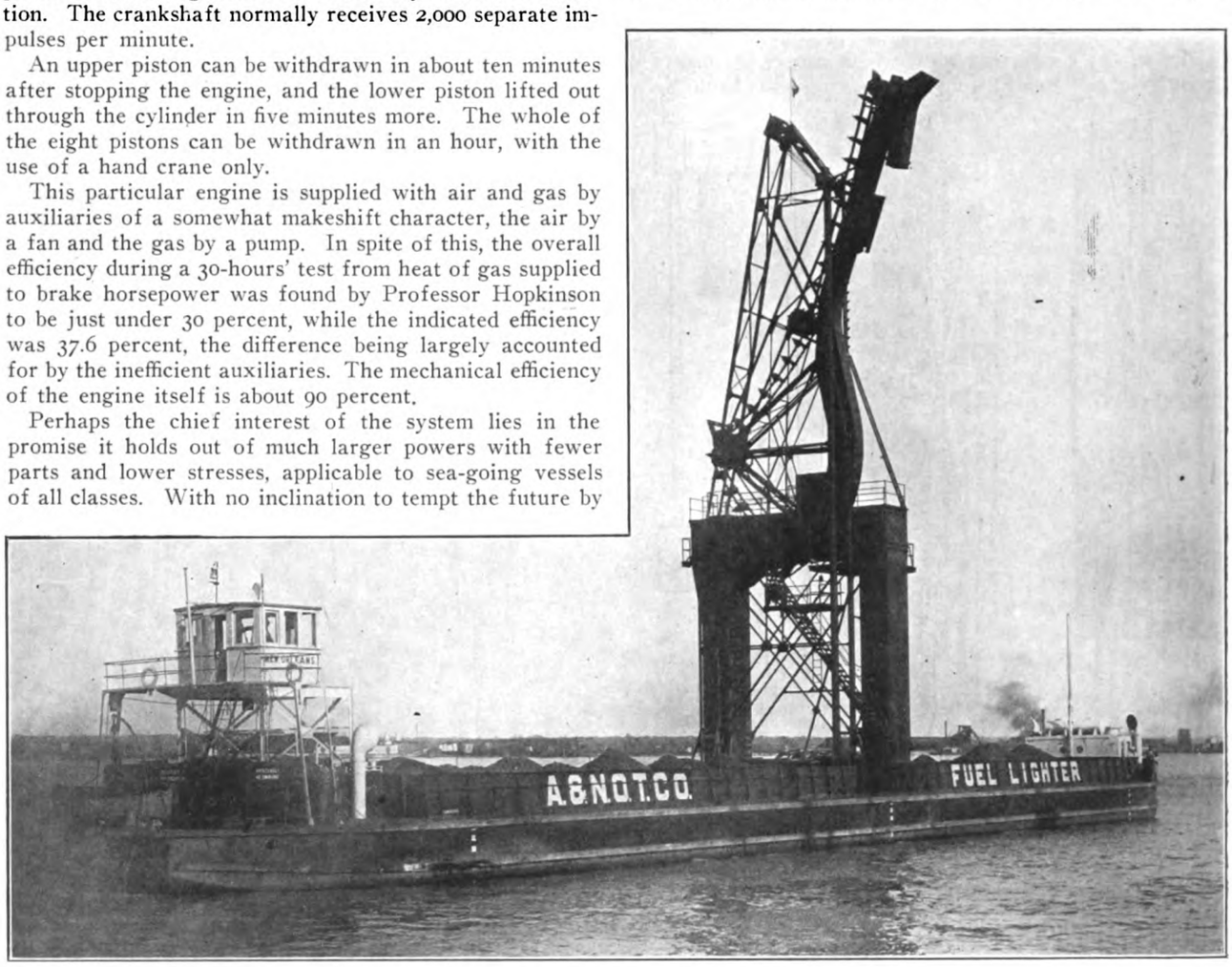

Fig. 1.—Self-Propelled Fuel Lighter of 1,000 Tons Capacity

The barge has a capacity of 1,000 tons of coal, the cargo space being divided into ten hoppers which are self-trimming with gates at the bottom to give access for the coal to two steel conveyors, one running from the bow of the barge to amidships and the other running from the stern to amidships. The conveyors drop the coal on steel hopper conveyors, which raise it in the square leg amidships, shown in the photograph, Fig. 2.

The bucket conveyor raises the coal to a height of 43 feet, and then it is moved over a scale and dumped into an S-shaped trunk which pivots around one point so that the trunk can be lowered and raised to reach any point between the water level and a height of 63 feet. At a height of 43 feet the beam overreaches the side of the fueling lighter, a distance of 30 feet.

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The coal movement in the trunk is held in check by means of a steel conveyor. No matter how low the point of delivery, the coal will pass through the trunk only at a predetermined speed, as it is held in check by a steel conveyor. The same steel conveyor also forces the coal through the trunk wherever it is raised to a point high enough so that coal will not be discharged by gravity.

The barge is propelled by three 80-horsepower fuel-oil engines, and, when fully loaded, has attained a speed of 9½ miles per hour. The propelling machinery, however, can be disconnected from the propeller shafts and used for operating the conveyors. As the power necessary to operate all of the conveyor machinery on the barge is

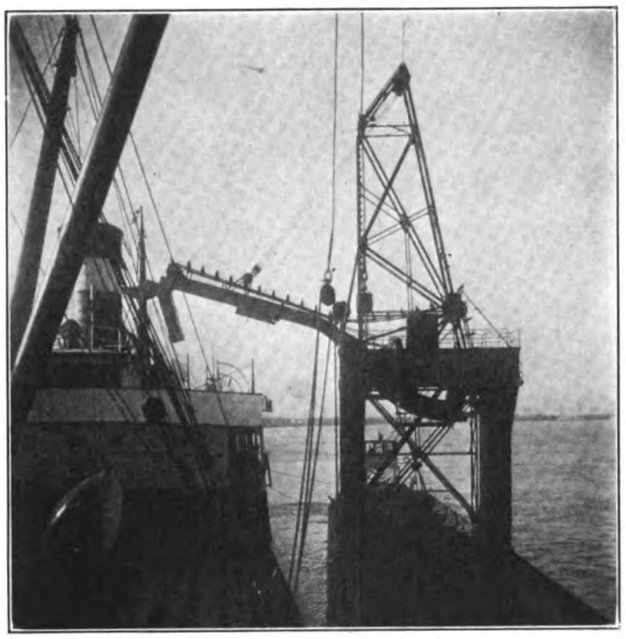

Fig. 2.—Fuel Lighter Preparing to Coal a Freight Steamer

less than 80 horsepower, it is only necessary to disconnect one of the propelling engines for this purpose, although either of the propelling engines can be connected through the clutches to the dynamo, which furnishes the power for the conveyor motors. All of the motors are operated from a platform on the square leg amidships in the barge.

Although the exact cost of coaling with this fuel barge has not been disclosed by the owners, it is nevertheless stated that, including the transfer of coal in the harbor of New Orleans for a distance of ten miles to the bunkers of steamships and trimming, the cost is less than 17 cents (0/8½) per ton, which is remarkably low, as it is necessary for the lighter to go 19 miles down stream to receive this coal. The bunkering of steamships in New Orleans harbor by other methods is seldom, if ever, less than 35 cents (1/5½) per ton.

The machinery for this barge was furnished by the Fairbanks, Morse Company, Chicago, Ill., the engineering department of which worked out the complete details for the coal handling machinery, as well as for the main engines.

New United States Destroyers.—Bids for the construction of the six new destroyers recently authorized by Congress were asked for on September 3. The vessels will be 310 feet long, 29 feet 10 inches beam and 9 feet 6 inches draft, with a displacement of 1,108 tons and a speed of 29 knots. Each will have four 4-inch rapid fire guns and four triple torpedo tubes.

The Mersey Bar Lightship Alarm

The Mersey Docks and Harbor Board has recently placed at the bar of the river the new lightship *Alarm,* which was built by Messrs. Hawthorne & Company, Ltd., of Leith, to the design and under the supervision of Commander Mace, R. N. R., marine superintendent of the Mersey Docks and Harbor Board, to a special class of Lloyds, and is of steel with specially heavy scantlings.

The leading dimensions are: Length between perpendiculars on the waterline, 104 feet; breadth, molded, 24 feet; depth, molded, 15 feet. There is a small ward room and accommodation for the master and mate aft, and two compartments forward for the crew. One of these is reserved for sleeping and the other for messing purposes. The vessel is subdivided by means of watertight bulkheads, and is designed so that she may float with any two of the compartments flooded.

Other adjuncts of the ship are: A large winch operated by compressed air from the same source as that used for the fog signals, an installation of the Marconi wireless telegraph apparatus and a submarine bell. The chief feature of the ship, however, is the illuminating apparatus, which differs in many ways from anything previously made. This has been designed and constructed by Messrs. Chance Bros. & Company, Ltd., of Birmingham, and is of the dioptric type, and claimed to be the largest yet fitted on any vessel of the kind.

The lighting mechanism is contained in a glazed lantern, 9 feet diameter, which is placed at the top of a built-up steel tower, 26 feet 6 inches high and 7 feet diameter, with internal spiral staircases. The candlepower of the beam given by the lamp, as determined by calculation, is 35,000.

As ships entering and leaving the Mersey pass very close to the vessel, arrangements have been made to diminish the glare of the beam—which might cause inconvenience to navigation—by using a mantle of a special size to reduce the intensity of the light. This mantle can be replaced by one of standard dimensions at any moment to give the full illuminating power when desired. The apparatus embraces several novel features, one of the most important of which is the arrangement of the pendulum. This contains the air and oil receiver for the incandescent burner, the air being supplied at a pressure of 65 pounds per square inch from one of the containers of the fog signal plant by means of a pipe carried up inside the tower, or alternately by means of a hand-operated pump inside the lantern. The incandescent burner carries a mantle 50 millimeters diameter.

The gimbal carriage and lantern have been designed to allow a movement of the pendulum of 45 degrees on either side of the vertical, this being the greatest movement which has ever been allowed in an apparatus of this kind.

The optical apparatus is of the "small third order" size, 375 millimeters focal distance, and gives a triple flashing characteristic. It comprises three panels of refracting and reflecting prisms, two of which subtend a horizontal angle of 99 degrees each, and the other panel 81 degrees, also a dioptric mirror of 81 degrees horizontal angle and 500 millimeters focal distance. The appliance gives three flashes in quick succession every 30 seconds, namely, a flash 0.58 second, eclipse 4.08 seconds, flash 0.58 second, eclipse 4.08 seconds, flash 0.58 second, and eclipse 20.10 seconds.

The lenses are supported by a steel cable carried by the gimball ball bearing, which itself is carried by means of the ball-bearing carriage, fitted with horizontal and vertical rollers, all with ball bearings. A further set of ball-bearing rollers is placed under the carriage so as to

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prevent the possibility of the apparatus lifting. The top table of the carriage is provided with a gunmetal race wheel, which is actuated by means of a bevel pinion in connection with horizontal and vertical shafts driven by clockwork mechanism, the latter being operated by a falling weight and steel wire rope guided in vertical ways in the tower.

The clock is placed on the floor of the lantern. All the main shafts of the clockwork mechanism are provided with journal and double-thrust ball bearings, the barrel shaft being of chrome vanadium steel, and the clock winding gear so arranged that it can be operated inside the lantern or at the bottom of the tower. If necessary the apparatus can be rotated by hand from inside the lantern and from the deck.

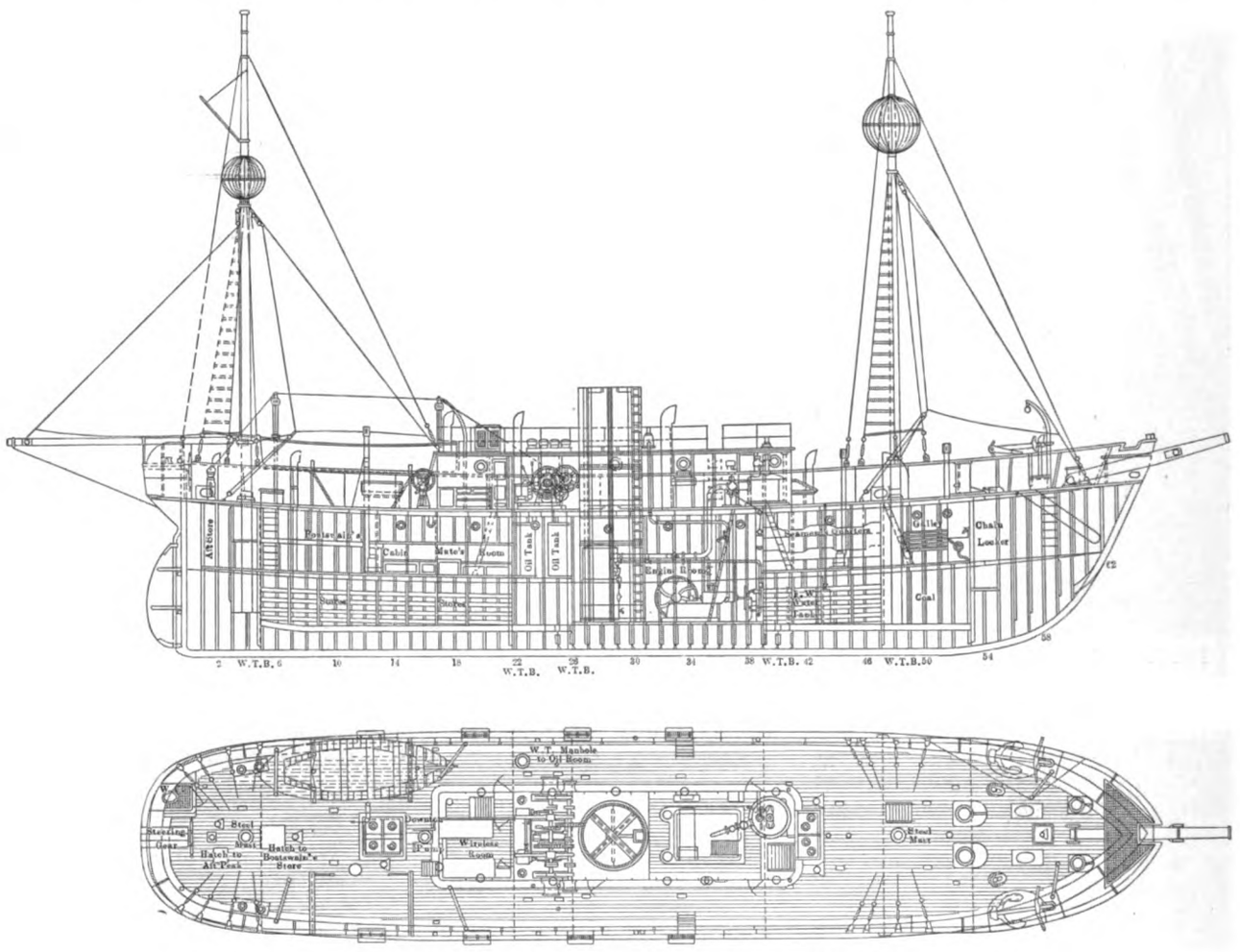
When not at work or when being cleaned the locking gear, consisting of three stays which fit into sockets on the pendulum casing, is used. One of these stays is adjustable in length by means of screw coupling. A further set of locking gear is provided between the top of the revolving carriage and the table which carries the lenses.

The lighting of the burner takes only a few minutes and can be performed by any unskilled man. The vaporizer is heated in a few minutes by means of a methylated spirit lamp in a well-known manner, and the oil is forced through the vaporizing tubes by the air pressure, when it issues as vapor and is ignited.

The fog signaling plant is designed to give a blast for two seconds during every 20 seconds. The compressing plant is in duplicate, each unit consisting of a double-acting, single-stage compressor, coupled direct to a Hornsby 11-brake-horsepower oil engine, and mounted upon a common base plate. Each unit alone is capable of maintaining sufficient air pressure to operate the signal, while one set is kept in reserve in case of breakdown. The engine and compressor cylinders are cooled by sea water, which is circulated by means of a pump driven off the crankshaft.

These compressors discharge into two air storage receivers of a total capacity of 200 cubic feet. These receivers are always charged to a pressure of 100 pounds per square inch, so that the signal may be sounded at a moment's notice and maintained for a space of about 15 minutes, which gives ample time to start up one of the engines. This is done by compressed air taken from the receivers, but as an alternative a small hand-operated air pump and receiver are provided. The air under pressure is led from the storage receiver to the sounding receiver in the deck-house through steel pipes of large diameter and easy bends, and the pressure at the siren is reduced by means of a valve to 25 pounds per square inch.

The siren is of the cylindrical pattern, giving a note of 182 vibrations per second, which corresponds with upper F sharp in the bass clef. In order to maintain uniformity of pitch, a friction governor is fitted to the siren. The siren and its admission valve are of the latest type, de-



Inboard Profile and Deck Plan of Mersey Bar Lightship *Alarm*

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signed to give as far as practicable a free and uniform air flow. The admission of air to the siren is controlled by means of a small pilot valve, which is actuated by a weight-driven clock having a governor to maintain the regularity of the sounding periods. The trumpet is of the vertical type, of cast iron, and is provided with a mushroom head of copper. In order to guard against any possibility of failure of the signal, the air piping and valves are so arranged that either or both compressors may deliver into either or both receivers, while a permanent record of the time and duration of the blasts of the siren is obtained by an autograph recording instrument.

New French Liner for West India Service

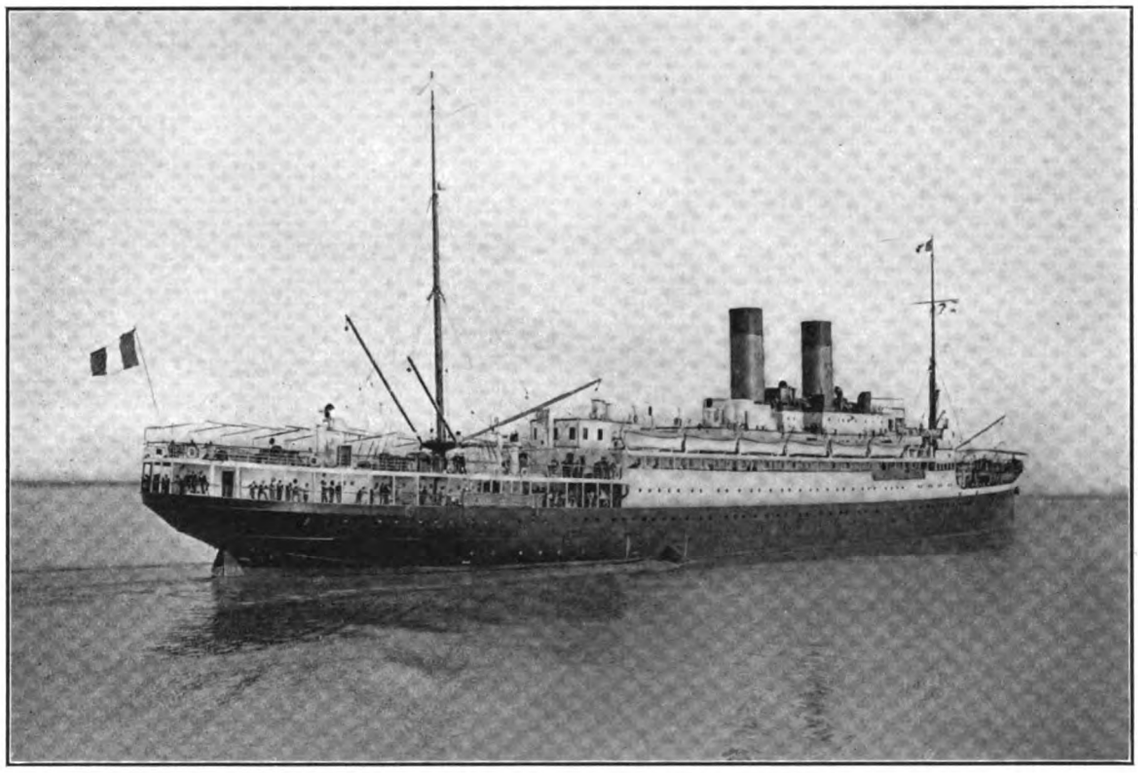
Description of the Quadruple Screw Steamer Flandre, Recently Built at the Atlantic Works of the Ateliers et Chantiers of St. Nazaire

On May 21, this year, a new freight and passenger steamer *Flandre* left St. Nazaire, France, en route for Vera Cruz and other Central American ports on her maiden voyage across the Atlantic. This boat has been specially designed for service between France and West Indian ports. She was built by the well-known firm of Ateliers et Chantiers of St. Nazaire (Penhouet), at their Atlantic Works, to the order of the Générale Transatlantique Company. The main particulars of the boat are:

Length overall	480 feet 4 inches
Length between perpendiculars	459 feet 4 inches
Beam	57 feet
Depth	37 feet 1 inch
Displacement at full load	11,330 tons
Speed	18 knots
Indicated horsepower	10,800

The hull of the vessel is divided into ten watertight compartments by transverse bulkheads; there is also a double bottom extending the full length of the ship, which is divided into twelve compartments, having a total capacity of 1,100 tons of water. There are in all seven decks designated as A, B, C, etc., decks, the F deck being the main deck.

One of the most interesting parts of the ship is the machinery. There are four screws, the two center screws being driven by reciprocating engines, and the two wing screws by low-pressure Parsons turbines. All of the large passenger vessels built in recent years at the Atlantic Works have this type of machinery. In fact, the first liner in which this arrangement was adopted was the steamship *Rochambeau*, built by this firm. The last one, which they have turned out prior to the *Flandre*, was the *Lutetia*, and, at the present time, two sister ships, the *Marsilla* and *Gallia*, are under construction at the Mediterranean works of this company, which will have the same type of machinery, except that on the *Gallia* there is only a single low-pressure turbine, whereas in the other ships each reciprocating engine exhausts into a separate low-pressure turbine.



The *Flandre* leaving St. Nazaire on Her Maiden Voyage

The reciprocating engines on the *Flandre* have cylinders 33 inches and 47 inches diameter with a stroke of 36 inches designed to work at 115 revolutions per minute. The low-pressure turbines are 67 inches in diameter and

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work at 420 revolutions per minute. The reciprocating engines develop 6,000 indicated horsepower, while the turbines develop only 4,800 horsepower. There are two condensers of the "Contraflo" type, making two independent steam plants in the ship.

Steam is supplied by six Scotch boilers, each 17 feet 9 inches diameter and 11 feet 6 inches long. There are in all twenty-four furnaces, the grate area amounting to 545 square feet and the total heating surface to 21,075 square feet. Designed for a working pressure of 200 pounds per square inch, the boilers are operated with Howden's system of forced draft and two funnels extending to a height of 100 feet above the grate bars.

All of the auxiliaries are of the latest type. The electric plant consists of three dynamos, electricity being used for lighting, ventilating and also for handling cargo and hoisting lifeboats. There are eight electric cargo winches and four electric lifeboat winches. The refrigerating plant has been specially designed for safe transportation of perishable goods.

The *Flandre* is fitted with a very complete outfit of appliances for navigating the ship, including a powerful wireless apparatus, twelve steel lifeboats, submarine signals, etc.

Accommodations are provided for 253 first class, 40 second class, 70 third class and 400 steerage passengers. On the awning deck is a large social hall for the first class passengers furnished in the period of Louis XVI. On this deck is also the first class smoking room finished in dark wood with leather upholstery. The rest of this deck is taken up with the staterooms de luxe for the first class passengers. Most of the first class staterooms, however, are on the promenade deck, the rooms having either one or two berths. Forward on the promenade deck are the doctor's and purser's staterooms, while aft is a children's play room. At the extreme after end of this deck is the second class smoking room and the main entrance to the second class accommodations.

On the deck below are the first and second class dining rooms, together with other first class staterooms. The main deck is given over principally to the second class passengers, while the third class passengers are berthed aft on this deck. Forward are the accommodations for the steerage passengers. The engineers, firemen and oilers are berthed on the main deck amidships in way of the boiler and engine rooms.

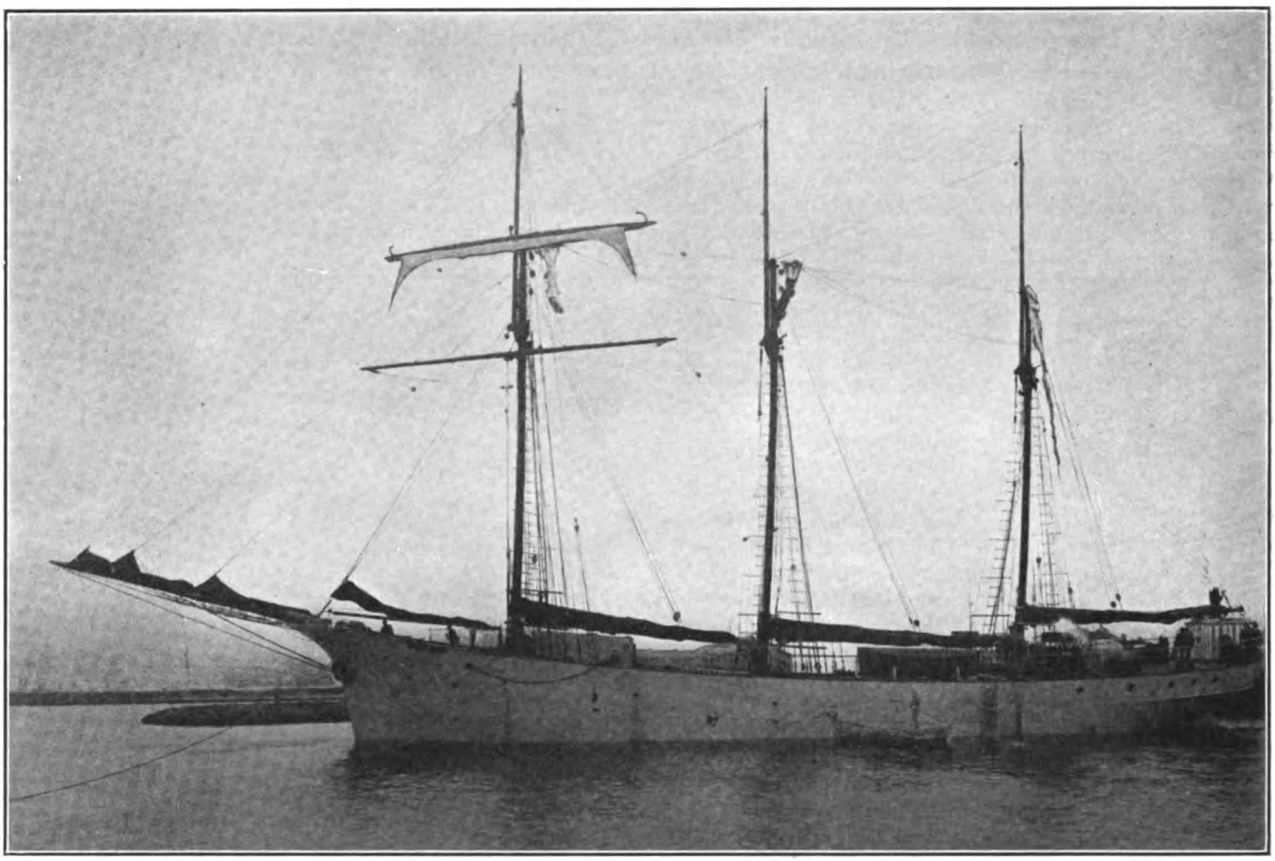

Fig. 1.—Tank Schooner *Bearnais*, Fitted with Auxiliary Diesel Engine

On her official trials, the *Flandre* attained a speed of over 19 knots, and it is expected that an average speed of 18.5 knots will be maintained in service.

STEAMBOATS ON THE OHIO RIVER LAID OFF.—On account of lack of business, and also owing to the holding up of river and harbor appropriations, many of the boats on the Ohio River have been placed out of commission and their crews laid off.

UNITED STATES REVENUE CUTTER STRANDED ON REEF.—The United States revenue cutter *Tahoma* struck a jagged reef and was stranded ninety miles to the westward of Kisha Island, off the far western Aleutian Islands, on September 20.

MALLORY LINER BURNED AT REPAIR YARD.—The passenger steamer *Nueces*, of the Mallory Line, was burned almost to the water's edge on the night of Sept. 18, while lying at the Tietjen & Lang repair yard in Hoboken, N. J.

LAUNCH OF THE GULFSTREAM.—The new tank steamer *Gulfstream*, of the Gulf Oil Company, New York, was launched at the yards of the New York Shipbuilding Company, Camden, N. J., September 17.

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A Diesel-Engined Tank Schooner

Description of Dutch Tank Schooner of 425 Tons Deadweight Capacity Fitted with 120 Horsepower Polar Diesel Motor

BY F. MULLER VAN BRAKEL

The tank schooner *Bearnais*, illustrated in Figs. 1 and 2, was built by Messrs. E. J. Smit & Son, of Hoogezand, Holland, for Messrs. J. F. Humaran & Company, coal tar distillers at Bordeaux, France, and will be used for the transport of raw materials and products to and from the owners' distilling works near Blaye. As the freight will be shipped either wholly in barrels, or partly in barrels and partly in bulk, oil tanks for carrying oil in bulk as well as an ordinary cargo hold are provided. The oil space is divided into four separate tanks by means of a longitudinal and a transverse bulkhead, and is separated from the other parts of the ship by means of the customary cofferdams. Each tank has an oiltight hatchway large enough to permit the passage of oil barrels when an all-barrel freight is shipped.

The principal dimensions of the ship are:

Length between perpendiculars	125 feet
Beam, molded	25 feet 6 inches
Depth, molded	11 feet 6 inches
Draft	10 feet 4 inches

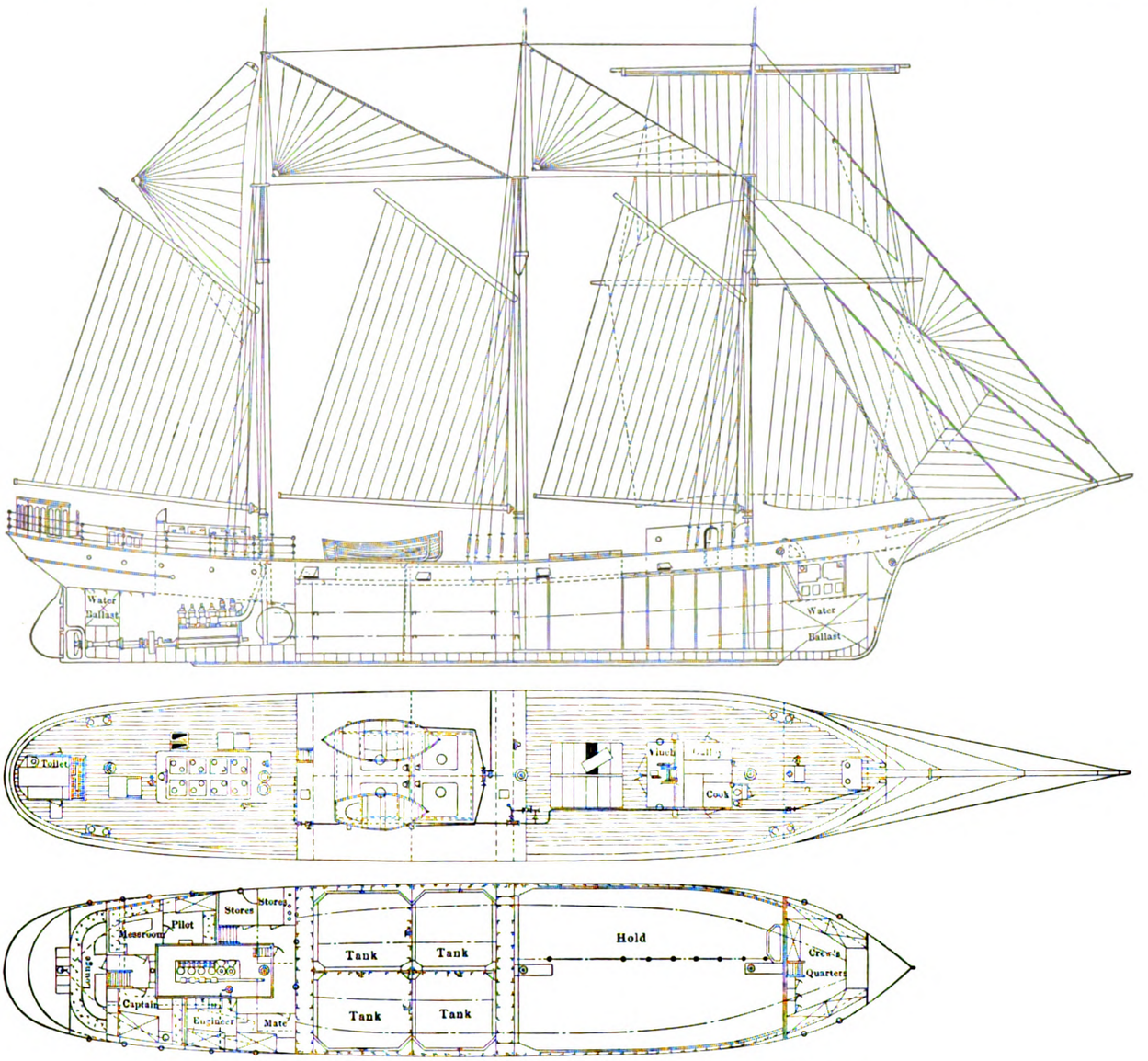

Fig. 2.—General Arrangement and Sail Plan of Tank Schooner *Bearnais*

Displacement at this draft	650 tons
Block coefficient	0.694
Coefficient of midship section	0.92
Deadweight capacity	425 tons
Gross tonnage	302 tons
Net tonnage	149 tons
Net tonnage to French rules (cofferdams deducted)	137 tons
Capacity for oil in bulk, exclusive of expansion trunks	50,000 gallons

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Capacity of cargo hold.....10,600 cubic feet
Capacity of forward peak tank for water ballast..27 tons
Capacity of after peak tank for water ballast....12 tons
Capacity of fuel tanks.....3,000 gallons
Effective horsepower.....120
Rig.....3 mast schooner
Class: Bureau Veritas ✠ I 3/3 A I. I.

As the ship is intended to make short trips between France, Scotland and Portugal, it is obvious that harbor dues will be an important item to the owners. Consequently they decided on oil engine power for three reasons: first, because by means of such arrangement the ship could profit as far as the measurement is concerned to the fullest extent of "steamship" propelling power allowances without impairing the deadweight carrying capacity by the heavier weight of boilers and steam engines; second, because the owners, being oil merchants, have easy access to oil and fuel; and third, to eliminate all towage expenses.

The structural arrangements present no novelties. That part of the ship which is taken up by oil tanks (some 33 feet) is constructed to the rules for ships carrying oil in bulk with bulkheads, web frames, additional side keelsons and stringers, oiltight riveting and expansion trunks.

The sunken poop deck situated over the engine room contains staterooms for the captain, mate, engineer and pilot, together with the messroom, lounge, two storerooms and a sail room. A small wooden deck house contains the hand steering apparatus, lamp room and toilet. A steel deck house placed on the upper deck just aft of the foremast is divided into two parts, the forward part containing the galley and cook's quarters, the other part being a winch room where a 2-ton electric winch is placed for working the ordinary cargo. The crew space is situated forward and accommodates five men.

The vessel is lighted by electricity and there is a powerful electric light for cargo working at night.

Machinery

The main engine is a two-cycle Polar Diesel motor of 120 effective horsepower, designed to run at a normal speed of 300 revolutions per minute. The four working cylinders are 11 inches diameter and 13 inches stroke. The pistons are provided with circular safety pieces of special cast iron screwed into the tops of the pistons to protect them from becoming overheated. If the cast iron safety pieces become overheated and crack, they may easily be replaced by spare pieces.

Besides the four working cylinders, there are two cylinders fitted with piston valves which are worked by compressed air for starting in the manner of an ordinary compound steam engine. As soon as the motor is started the air-admission valve is closed and the air-starting cylinders automatically become scavenging cylinders.

On the tops of the maneuvering cylinders are placed the high- and low-pressure compressors, of which one is a duplicate. Starting and reversing is almost instantaneous, the reversing from full power ahead to full power astern being accomplished in six seconds. The motor can be slowed down to 60 revolutions per minute.

Besides the main engine and three main fuel tanks, there are in the engine room a crude oil motor of 6 horsepower for driving the dynamo and the auxiliary compressor, two main compressed air reservoirs, one auxiliary compressed air reservoir, two auxiliary fuel tanks containing motor fuel and kerosene (paraffin) respectively—the kerosene (paraffin) being for starting the motor when cold—one auxiliary fuel tank for the 6 horsepower motor, two hand fuel pumps, etc. An engine telegraph, speaking tube and a compressed air whistle are placed within easy reach of the men at the wheel.

Convention of Atlantic Deeper Waterways Association.—The seventh annual convention of the Atlantic Deeper Waterways Association was held at the Hotel Majestic, New York, September 22, and on the Hudson River steamer *Berkshire* on September 23, 24, 25, 26 and 27. On the second day of the convention a tour of inspection was made of the waterfronts of Manhattan, Brooklyn and Jersey City. On the third day the delegates and guests of the association proceeded up the Hudson River on the steamer *Berkshire,* calling at West Point, Newburgh, Poughkeepsie, Kingston and Hudson. The fourth day was spent in Albany and the fifth day in Troy. At various sessions of the convention papers were read on The New York State Barge Canal, The Upper Hudson Improvement, The Atlantic Intracoastal Waterway Chain, Modern Barge Navigation, Steel Barge Construction, New York's Waterways, Local River Improvements and Progress in New England.

New Canadian Pacific Steamers.—Two new Canadian Pacific liners for transatlantic service are nearing completion at the yards of Messrs. Barclay, Curle & Company, Whiteinch. The first of these, the *Missanabie,* will leave Liverpool for Montreal October 7, and her sister ship, the *Metagama,* will soon follow her. These vessels are 520 feet long, 64 feet beam and 41 feet deep, with a gross tonnage of 13,000 tons. The displacement is 18,000 tons and the cargo capacity 400,000 cubic feet. Accommodations are provided for 520 cabin and 1,200 third class passengers, which, with a crew of 300, brings the total capacity up to over 2,000.

United States Battleship California.—The United States battleship *California,* authorized by Congress June 30, 1914, will be 624 feet long overall, 600 feet long on the waterline, 97 feet beam molded, 21 knots speed, and at a draft of about 30 feet will have a displacement of about 32,000 tons. The armament will consist of twelve 14-inch guns, twenty-two 5-inch rapid fire guns and four submerged torpedo tubes. The vessel will be propelled by turbines supplied with steam by oil-burning watertube boilers. The cost of the vessel, exclusive of armor and armament, will be about $7,800,000 (£1,600,000) and the total cost $14,920,000 (£3,060,000).

Loss of the Admiral Sampson.—On the morning of August 26 the Alaskan liner *Admiral Sampson* was sunk in Puget Sound with the loss of eleven lives, through a collision in dense fog with the fast Canadian Pacific passenger liner *Princess Victoria.* The *Princess Victoria* struck the *Admiral Sampson* on the port side abreast the after hatch, inflicting a wound which caused the American liner to sink in less than ten minutes. The damage to the *Princess Victoria* was such that sixteen bow plates will have to be renewed and a section of the stem replaced. The contract for this work has been awarded to Yarrows, Ltd., of Esquimalt, B. C.

Record Voyage to San Francisco.—The American-Hawaiian freight steamship *Pennsylvanian,* sixteen days out of New York, arrived in San Francisco September 17, having made the fastest voyage between the two ports ever made. The first vessel to reach New York from San Francisco via the Panama Canal was also an American-Hawaiian steamer, the *Nebraskan,* which completed her voyage September 6.

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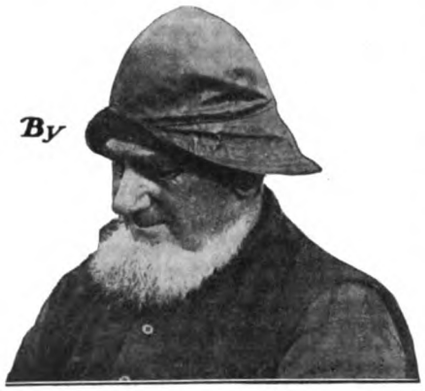
Economy Talks "Old Scotch"

By



How to Tell When the Boilers are Properly Fired

Well, all you fellow horny-handed sons of toil, I am still going on with my remarks about combustion, as that's where the main part of this ten percent saving is coming from.

After all these rules about combustion and firing I've been telling you about, I guess you will want to know how you are going to tell when you are firing right. A fellow might think he is the real thing in almost any line, but it takes some impartial judge to tell him just where he gets on and off. Judgment is all right in its place, but instruments are better, as they can tell no lies. The real test of good firing is the amount of this CO_2 (carbon dioxide) that the gases contain just as they leave the boiler. That tells the tale of how the firing is done and whether too much air is leaking into and around the furnaces.

As this gas doesn't have any particular smell, it can't be expected that you can stick your nose into it and tell right away how much of that stuff is in the gases, so some people on shore have rigged up what they call a "gas analysis set." With this dingus you can read off the amount of CO_2 just as easy as you would measure out oil or water. It doesn't cost very much, and if you are going into this profit-sharing game you can afford to buy one, after you have made the necessary arrangements with the ship-owners.

Then, too, you will want to know the temperature of the gases going out of the boiler, as that gives you a line on what is being done inside. This is found out by using a special thermometer called a "pyrometer," and it doesn't cost very much, either. With these two instruments you can keep a very good line on what you are doing.

The low water mark on the CO_2 should be ten percent, and everything above that is so much the better to a certain extent. For instance, in some plants on shore where they have up-to-date managers they pay their firemen bonuses based on the amounts of CO_2 maintained. Ten percent is the minimum on which a bonus is paid, and compared with that the pay for 13 percent is four times as much. The mill owners find it pays them to give these bonuses, and the firemen are dead sure that it pays them to watch everything closely. If the CO_2 falls down from 10 percent, say to 5 percent, the fuel loss is about 25 percent, so it behooves you to keep it up to 10 percent or better if you want to save fuel.

The stack temperature does not indicate what is being done in the furnace so much as it does the efficiency of the boiler itself. As a general thing the temperature of the escaping gases at the bottom of the stack should not be much more than 100 degrees higher than the temperature of the steam which the boiler is making. Some stacks, if the fires are not properly handled, have been known to get so hot that they would set fire to the woodwork in their vicinity.

If all of the heat of combustion were applied to raising the temperature of the products of combustion, including the ash, the temperature over the fire in a furnace might run up to about 3,500 degrees F. Such a temperature, however, is never approached in the furnace of a boiler, for the combustion is a comparatively slow process and usually is not completed in the furnace. The flames extend over the bridge wall into the combustion chamber, and all the time there is an active radiation of heat from the burning fuel and gases and a rapid transfer of heat to the heating surface of the boiler. For this reason the temperature directly over the fire usually does not get much above 1,200 degrees F.

If the CO_2 falls down below the limit I have given you, you can be pretty sure that one of two things is happening, or perhaps both together. That is, your fires are too thin and allow the air to blow through them, or else there are bad air leaks around the boiler casings. In either case you want to remedy the evil just as quickly as the Lord will let you. If your fires have to be carried a little thicker and the next reading of your gas analysis shows the correct amount of CO_2, then mark the depth of your fires on your furnace fronts and try to carry them at this thickness afterward.

You must take great care to prevent air leaks, especially if you are using watertube boilers. In Scotch boilers there is not so much of a chance for air to leak into the furnaces except at the fronts, which you can control very readily. With boilers having casings it is different, as the air manages to leak in at all kinds of places. The only way to prevent it is to go nosing around the casings carrying a lighted candle. If there is an air leak the flame will be drawn into the crack or pinhole, or whatever it is. Some people may not like the idea of having hot candle grease dropped on their fingers or their knees, or whatever part is directly under the candle. If such be the case let them get a pine stick and dip the end of it in alcohol. This makes a fairly good torch without any drippings.

As soon as any leak is found, plug it up at once. Ordinary fire clay will do, but it may not last long. Therefore, mix it up with some asbestos fiber and it will do first rate to fill up large openings. Small leaks may be calked with asbestos rope and red lead. It doesn't matter so very much what you use as long as you stop the air from going into the furnace at all places except the right opening.

Next time I am going to discuss other matters about boilers, as I reckon you are tired of learning so much about combustion. You know, of course, that combustion is all about hot air, anyhow.

Yours for economy,

Old Scotch

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Questions and Answers for Marine Engineers

Inquiries of General Interest Regarding Marine Engineering and Shipbuilding will be Answered in this Department

CONDUCTED BY H. A. EVERETT *

This department is maintained for the service of practical marine engineers, draftsmen and shipbuilders. All inquiries should bear the name and address of the writer. Anonymous communications will not be considered. The identity of the writer, however, will not be disclosed unless the editor is given permission to do so. Indicator cards taken from marine engines will be carefully analyzed, the defects pointed out, and the horsepower calculated, provided complete data are sent with the cards.

Q.—What will be the pressure on the low-pressure crank, neglecting weight of parts, for a cylinder 72 inches in diameter with 10 pounds pressure in the receiver, and 26 inches vacuum? M. P.

A.—Neglecting also the effect of the valve and ports, there is a possible difference of pressure acting on the piston of $10 + 14.7 - 2 = 22.7$ pounds per square inch. On a piston 72 inches diameter this would give an effective force along the piston rod of

$$\frac{\pi \times (72)^2}{4} \times 22.7 = 4{,}072 \times 22.7 = 92{,}400 \text{ pounds}$$

which may be resolved into components along the connecting rod and perpendicular to the crosshead guide. With

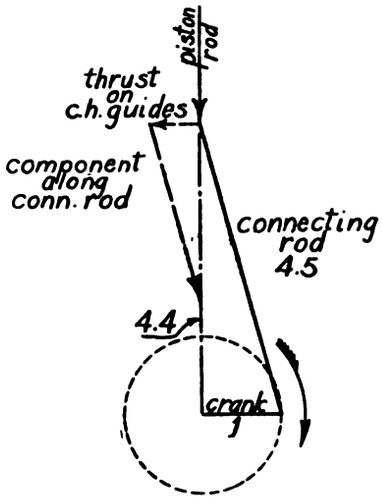

Diagram of Forces on Crank.

the customary ratio of connecting rod to crank of 4½, we have, when the crank is at 90 degrees, the maximum force of

$$\frac{4.5}{4.4} \times 92{,}400 = 94{,}500$$

(See sketch.) This is the greatest pressure on the crankpin. It should be borne in mind that accepting the difference between the receiver and condenser pressures as the effective pressure is but a rough assumption, and is unsatisfactory for refined calculations. It, however, generally gives a value in excess of that obtained by the more correct method of taking the difference in pressure from the indicator diagrams and correcting for the effects of reciprocating parts and weights.

*Assistant Professor of Naval Achitecture and Marine Engineering, Massachusetts Institute of Technology, Boston, Mass.

Q.—If I know the developed area of a propeller, can I find the projected area except from the drawings? L. T. T.

A.—Yes. Barnaby gives in his book on propellers.*

$$\text{Projected Area} = \frac{\text{Developed Area}}{\sqrt{1 + 0.425\left(\frac{\text{Pitch}}{\text{Dia.}}\right)^2}}$$

which gives a good approximation to the result desired.

Q.—As the difference in temperature of the steam entering and leaving a cylinder of a steam engine is increased, what source of waste is greatly increased, and how can this waste be partially avoided? ENGINEER.

A.—The condensation on the cylinder walls (frequently called initial condensation). This can be minimized by steam jacketing the cylinders.

Q.—How much more power will it take to drive a four-bladed propeller than a three-bladed one, if the dimensions are the same? A. L.

A.—From 23 to 30 percent more for the same revolutions, depending upon characteristics of form and operation. For detailed information on this subject see "Speed and Power of Ships," by D. W. Taylor.

Q.—How will I figure the amount of steam which a 3-inch pop-safety valve will discharge? MAC.

A.—The data necessary are steam pressure and quality, area of opening of seat and amount valve lifts; knowing these, the discharge can be figured approximately, using the thermodynamic formulæ for flow of steam through an orifice. The best information on this subject is contained in a paper to the American Society of Mechanical Engineers, by E. F. Miller,† in which are given the amounts *actually discharged* through 3-inch and 3½ inch valves of different styles, and under different conditions. The following table is compiled from this:

TABLE OF STEAM DISCHARGES OF CROSBY MUFFLED LOCOMOTIVE POP SAFETY VALVES (WITH ROUNDED SEAT EDGE) IN POUNDS OF STEAM PER HOUR.

Valve Size.	Pressure By Gage, Lbs	Lifts (Inches)			
		.02	.05	.08	.10
2½	160	1,819	4,380	6,599	8,078
	180	2,027	4,882	7,354	9,003
	185	2,080	5,007	7,543	9,235
	200	2,235	5,383	8,110	9,928
	205	2,288	5,508	8,299	10,159
3	160	2,217	5,354	8,033	9,809
	180	2,470	5,967	8,952	10,932
	185	2,534	6,120	9,182	11,213
	200	2,724	6,580	9,872	12,055
	205	2,788	6,733	10,102	12,336
3½	160	2,647	6,326	9,437	11,361
	180	2,950	7,050	10,517	12,662
	185	3,026	7,231	10,787	12,987
	200	3,253	7,774	11,598	13,962
	205	3,329	7,955	11,868	14,288

Q.—Please calculate the horsepower from the inclosed cards taken from a twin-screw car ferry steamer equipped with engines having jet condensers, and air pumps attached to the intermediate crossheads, eccentrics keyed on, Stephenson link motion, piston valves on the high and intermediate and double-ported slide valve on the lows. These engines will develop much more power, but this is all that is required. We have made an effort to make each cylinder develop the same power. I notice the usual practice is a large increase of power in the intermediate over the high, and a large increase in the low over the intermediate. Is there any good reason for this? F. L. M.

* Marine Propellers, by S. W. Barnaby.

† Results of tests on the discharge capacity of safety valves. 1910.

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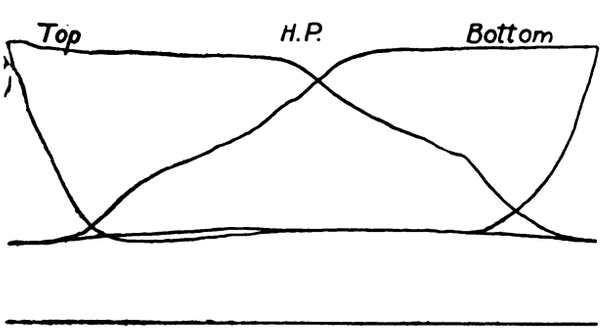
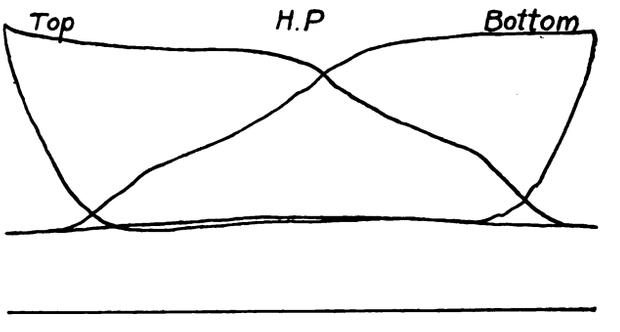
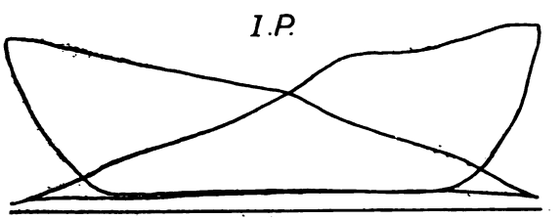
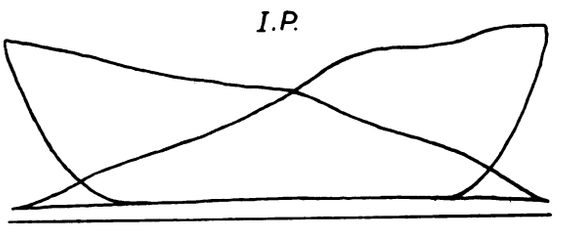
A.—The solution for indicated horsepower by means of the planimeter and assuming 4½-inch piston rods, is tabulated at the bottom of this page.

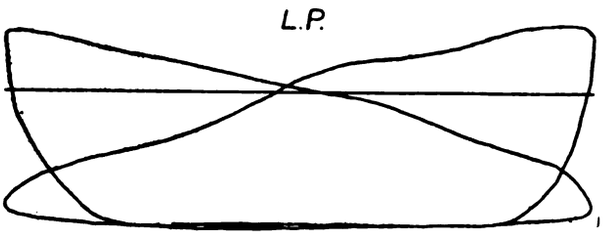
The low-pressure cards are excellent. The intermediate and high would be improved by working the gag screws for these cylinders to give a later cut-off and release. This would also improve the distribution of power, which should be equal for each cylinder. The greater power which is frequently found in the low-pressure cylinder is the result of poor design or to offset attached auxiliaries. It is well to test out the effect of small movements of the high-pressure gag screw upon both the high-pressure and intermediate-pressure cylinder by taking cards on these cylinders before and after changing, but without removing the cards from the indicators so as to get the cards showing the change superposed on the cards in the present condition. It is quite possible that the moving of the high-pressure gag alone will remedy the defects of both cards. In your case, as the air pumps are attached to the intermediate cylinder, it would be desirable to have that cylinder have an excess of power about equal to that required for the air pump. The droop in the back pressure lines of the high-pressure cylinder indicates a slight



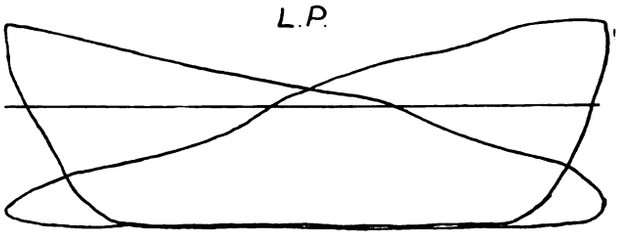








Indicator Cards from Port Engine



Indicator Cards from Starboard Engine

CARDS OF TRIPLE EXPANSION ENGINE.

$\frac{19x31x53}{36''}$ at 92 R.P.M.

			Area Square Inches.	Length Inches.	Spring.	M. E. P.	Area of Piston.	I.H.P.	I.H.P. Per Cyl.	I.H.P. Total.
Starboard Engine	H.P.	Top	3.35	4.13	80	64.8	283.5	153.8		
	H.P.	Bottom	2.88	4.13	80	55.8	267.6*	125.1	278.9	
	Int. P.	Top	2.13	3.75	40	22.7	754.8	143.1		
	Int. P.	Bottom	2.07	3.75	40	22.1	738.9*	136.5	279.6	
	L.P.	Top	3.58	4.20	10	8.52	2124	151.1		
	L.P.	Bottom	3.45	4.20	10	8.24	2108*	145.6	296.7	855.2
Port Engine	H.P.	Top	3.37	4.11	80	65.5	283.5	155.2		
	H.P.	Bottom	3.03	4.11	80	59.4	267.6*	132.8	288.0	
	Int. P.	Top	2.20	3.78	40	23.3	754.8	147.0		
	Int. P.	Bottom	2.18	3.78	40	23.1	738.9*	142.8	289.8	
	L.P.	Top	3.47	4.12	10	8.44	2124	150.0		
	L.P.	Bottom	3.40	4.12	10	8.26	2108*	145.7	295.7	873.5
Total										1728.7

*Assuming piston rod = 4½ inches diameter and no tail rods.

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throttling of the steam during exhaust, presumably caused by insufficient ports or excessive exhaust lap on the valve.

Q.—If the temperature of steam supplied to an engine is 331.161 degrees F., and the temperature of the exhaust is 219.452 degrees F., what is the thermal efficiency of the engine? D. O. S.

A.—The quotation of temperatures beyond the first decimal place is absurd for steam engineering work. The efficiency of the Rankine cycle (commonly called the thermal efficiency) between any temperatures is:

$$\text{Efficiency} = \frac{\text{Heat used}}{\text{Heat supplied}} = \frac{H_1 - H_2}{H_1 - h_2}$$

For this case the *heat used* is the heat contents of the steam at 331 degrees (H_1) less the heat contents of the steam exhausted at 219 degrees (H_2) after adiabatic expansion. The *heat supplied* is the heat contents of the steam at 331 degrees (H_1) less the heat contents of the condensed steam (which is the heat of the liquid) at 219 degrees (h_2). Assuming 8/10 percent moisture in the steam at admission, the solution using Peabody's Steam and Entropy Tables is:

$$\text{Efficiency} = \frac{1180.0 - 1047.1}{1180.0 - 187.4} = .134 \text{ or } 13.4 \text{ percent.}$$

Q.—I am on a freight steamer 471 feet by 57 feet beam by 27 feet draft. Is it possible, without having the lines, to figure how much weight is required to sink her 1 inch? If so, how is it done? L. D.

A.—It is impossible to figure accurately the tons per inch of immersion without the "lines."

$$\text{Tons per 1-inch immersion} = \frac{\text{Area Waterline Plane (square feet.)}}{12 \times 35}$$

If the boat is a freighter, she is probably full formed and one can estimate the area of the load waterline, say approximately 87 percent of the surrounding rectangle, whence

$$\frac{.87 \times 471 \times 57}{12 \times 35} = 55.6$$

would be the tons per inch of immersion at load draft. At lighter drafts it would be less, as the waterlines are finer. Load waterline coefficients vary from .8 to .9 (80 percent to 90 percent) for full ships of 350 feet and over.

Q.—How is the power determined for the large Diesel engines now coming into use on seagoing vessels? O. E.

A.—By using the indicator, as with steam engines, but using a special type of indicator suitable for withstanding the very high temperatures encountered. These engines before installation are usually indicated and also run direct-connected to an electric generator, from which the power delivered is measured. Knowing the generator losses, the brake horsepower is readily found. In service the engines are indicated but rarely, as derangements are noticeable in other ways. There is, however, no especial difficulty in taking diagrams except where the crosshead and connecting rod are housed-in and it is hard to get at the piston motion.

Steam Lighter America

The steam lighter *America*, said to be the largest of her type ever built on the Atlantic coast, has just been launched at South Portland, Me., and is now having her machinery installed at that place. The *America* is 190 feet long, 38 feet wide, has a depth of hold of 16 feet and a capacity of 1,600 tons of stone. She cost $70,000 (£14,400).

The *America* was built and is owned by Philip H. Doyen, a contractor of Portland, who will use her in the construction of breakwaters and for the transportation of heavy stone in connection with other contracts. For the handling of this unwieldy commodity she has been fitted with one of the biggest derrick masts ever stepped. It is of Oregon pine 114 feet long and 29 inches at the butt. The hoisting machinery is located forward and the propelling machinery aft.

While the *America* was being launched, she stuck on the ways, and for several weeks resisted all attempts at starting again. In accordance with a clause of her insurance policy covering builders' risks, the underwriters, Messrs. Norton, Hall and Webster of Portland, at length took charge of the operations and floated her successfully, the operation costing $3,000 (£615).

Inlets Disastrous to Seagoing Steamers

Probably no steamship line on the Atlantic coast conducts its business under more difficulties than the Atlantic City Transportation Company, which operates seagoing freight and passenger steamers between New York and Philadelphia and the famous beach resort. The reason for this is that Atlantic City is on Absecon Inlet, which has a depth of only 12 feet of water at low tide, and is practically impassable in rough weather.

The last mishap to a steamer of the line occurred on September 13, when the 927-ton steel steamer *Atlantic City*, the newest and largest of the fleet, went ashore in a gale while bound down from New York, with 31 passengers aboard. Attempts are now being made to float the ship, which was built only two years ago at Port Richmond, N. Y., and has withstood the hammering well.

On December 31, 1911, the iron steamer *Alpha* went ashore on the bar and was later thrown in high and dry on the beach, her position being a very difficult one for the wrecking company and the crews of the Atlantic City and Absecon life-saving stations, who floated her after several months. As it was, her cargo of freight, valued at $6,000 (£1,300), was lost. The *Alpha* is of 366 tons and was built at Philadelphia in 1881. She was formerly the *Conoho*, engaged in freighting on the Maine coast before being acquired by her present owners.

The iron steamer *Brazoria*, of the same fleet, was wrecked on the bar August 26, 1910, while bound to Atlantic City from Philadelphia. Before wreckers could get to work on her she broke in two, and, together with her cargo, the whole valued at over $30,000 (£6,150), became a total loss. The *Brazoria*, originally the *Meteor*, was built at Philadelphia in 1883, and registered 423 tons.

DAMAGE TO THE STEAMER CITY OF CHICAGO.—The steamer *City of Chicago*, of the Graham & Morgan fleet on Lake Michigan, which was partially destroyed by fire at the mouth of the Chicago River early in the morning of September 1, is to be brought to Benton harbor and later, under her own steam, will probably go to Manitowoc, Wis., to have her superstructure rebuilt. When the fire broke out the vessel was brought to a position of safety in a heroic manner by her captain and her chief engineer, William F. Johnston, of St. Joseph, Mich., who stuck to his post in the engine room until the vessel had been driven into the breakwater at the entrance to the harbor and wedged fast, so that the passengers and crew, to the number of 120, were put safely ashore without the slightest injury to anyone. Only the after third of the vessel between decks and the cabins and staterooms above that portion of the vessel were damaged. The engine suffered no damage except the shakeup from running the steamer into the breakwater. The only damage to the steel hull was the buckling of half a dozen plates at the bow and the bending of the stem. It is probable that her entire superstructure above the main deck will be rebuilt and that the steamer will come out in the spring of 1915 better equipped than ever.

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Letters from Practical Marine Engineers

A Department for the Readers' Discussion of the Design and Handling of Marine Engines, Boilers and Auxiliaries—Breakdowns at Sea and Repairs

This department is open to all readers of the magazine for the discussion of affairs in the engine room. All letters published are paid for at regular rates. Your ideas or experiences will be mutually helpful and interesting to other engineers. Write your letter now.

Is the Turbine a Steam Hog?

Many practical engineers have the idea that the steam *rushes* through a steam turbine and that a turbine is exceedingly more wasteful of steam than a reciprocating engine; indeed, it has been the dream of more than one inventor to harness that *wasted* steam—sort of box it up and keep it from escaping, so that it might in some way do more work. So prejudiced are some that they will not listen to talk of water rate or steam consumption per horsepower, and yet these very figures compared by proper units prove conclusively that turbines are operated with less steam consumption per horsepower than reciprocating steam engines of equal capacity.

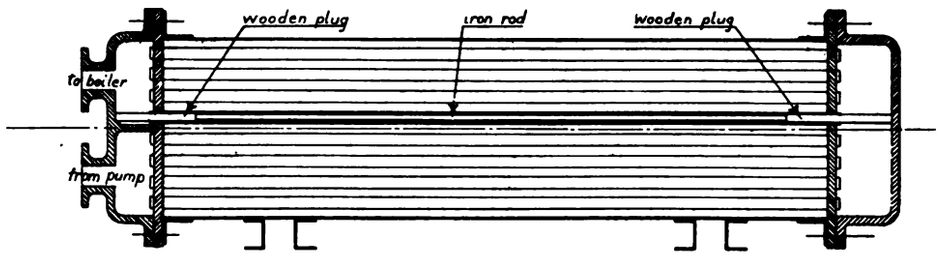
Probably the difficulty is for the engineer to understand that the elastic property of steam may be used in at least one other way besides that of expanding behind a piston, thus forcing it in or out on its stroke, as the case may be. It is understood that one pound of steam contains just as much energy as another pound of steam under the same conditions of pressure and temperature. This energy in the steam is heat energy, and must be changed into mechanical energy to do work. In the reciprocating steam engine the steam exerts a pressure on the piston and expands, losing heat; but in so doing it forces the piston in or out on its stroke and the piston moving alternately in and out transfers its motion through crank and connecting rod to the shaft where mechanical work is done. During this transformation of energy from one form to another a comparatively large amount of energy is lost through friction, radiation of heat, etc.

Now in the steam turbine the steam is expanded in a nozzle or its equivalent, giving up most of its heat energy but producing a very high velocity, with which it impinges on the blades of the drum or rotor, causing it to rotate, thus transforming the heat energy into mechanical energy also in the form of a rotating shaft. The losses in this transformation of energy are due to radiation, friction, etc.

Of course in both reciprocating engine and turbine energy is lost through the exhaust, but in both all loss is due to mechanical impossibilities, and therefore what applies to one on exhausting applies equally well to the other. It is easily seen that if theoretical perfection were possible, then the turbine and reciprocating engine would both develop the same power from the same amount of steam under the same conditions of pressure and temperature, because if theoretical perfection were attainable then there would be no losses, and if there were no losses all the energy in the steam would be converted into useful work.

By actual comparison these losses are found greater in the reciprocating engine than in the turbine, and therefore the turbine develops more power or creates more mechanical energy out of a pound of steam than a reciprocating engine. Therefore under the same conditions and comparing units of equal capacity for doing work, the steam consumption of the turbine per horsepower is less than that of the reciprocating engine, and this is due to mechanical or practical considerations only.

Brooklyn, N. Y. J. L. WILSON.



Section through Feed Water Heater Showing Location of Plug

Repairs to Feed Water Heater

Some years ago I had occasion to plug a feed water heater and had not enough time to remove both heads. It was a cast iron horizontal condenser type of heater about 8 feet long and containing about 60 tubes ¾ inch in diameter. The inlet and outlet nozzles for the feed pipe connections were on the forward head, so that removal of this head necessitated taking down the sections of pipe connecting with them.

No bypass had been provided and a split tube put the feed pump out of service, as the water leaked back to the exhaust steam space and thence to the condenser through the exhaust outlet. The injector would not take water from the hot well and we could not carry enough to make the run, and of course we would not use sea water unless unavoidable.

I had two hours before "leaving time" and I saw that it would not be possible to take down the sections of pipe and both heads and replace them in this time. So I took down the after head, located the split tube and made a white pine plug that I could just push through the tube. Then using a ½-inch iron rod I pushed the plug clear through until it took up against the forward head, as shown in the sketch. I then cut the rod off so that when the forward end was against the plug the after end was about three inches inside the after end of the tube. An-

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other pine plug in the after end of the tube long enough to reach the rod completed the repair, and replacing the head I was ready to sail with a half hour to spare.

This proved thoroughly satisfactory and was run for several months before a permanent repair was made. Of course on our later installations of heaters we provided bypasses for both feed water and exhaust steam, and also made the pipe connections on a distance piece or neck between the head and tube sheet, so that the heads might be removed without disturbing any piping. Thus do we gain wisdom by experience. S.

Faulty Designing of Boilers

The writer believes that many boilers are designed without due regard to their efficiency and lasting qualities. All marine boilers are designed according to rules and regulations that have the force of law, but these rules and regulations only take note of the elements that enter into the question of safety, having no regard at all to the efficiency or upkeep of the boilers. The following experiences of such faulty design are a few of the many that have come under the writer's personal observation during a period of 25 years as a marine engineer.

A leg boiler was installed in a small tugboat and in a few weeks the side sheets in the furnaces commenced to bulge between the staybolts. The builders of the boiler were notified and they immediately stated, as a reason for this, that there was grease in the boiler. Examination of the boiler failed to discover any evidence of grease at all, but they persisted in the statement that it must be grease—that there could be no other cause for this bulging. The bulging became worse and the superintendent engineer decided to look for the cause himself. This boiler foamed considerably, particularly when the safety valve lifted while the engines were running. He inserted a gage cock in the outside of one of the legs and found that when the boiler foamed only dry steam came out of this gage cock when it was opened, showing that the foaming lifted the water entirely out of the legs.

The space between the sheets in the outside legs was only 4 inches and in the center leg only 6 inches. Evidently this was entirely inadequate to allow for the proper circulation of the water in the legs under certain conditions. A much better design would have allowed 6 inches between the sheets in the outside legs and 8 inches in the center leg. The difficulty was overcome to some degree by placing baffle plates under the steam opening, which partly stopped the foaming, but by the time this was done the side sheets were bulged so badly they had to be cut out and replaced with new material.

Another case of faulty design, and one that is too frequently found, occurred on a coastwise tugboat. The sheet in the back connection of the boiler began to bulge opposite and above the mouths of the furnaces. This sheet was stayed according to the rules and regulations, which provide that the stress on staybolts must not exceed 6,000 pounds to the square inch of section. The bolts were made large and spaced 7½ inches apart, leaving a large square unsupported except at the corners. It was suggested that extra stays be placed in the bulged parts of the sheet in the center of the squares. This was vigorously opposed by the builders of the boiler, who insisted that the boiler was properly designed and did not need any extra stays, although they could not—at least would not—give any reason for the bulging. However, the extra staybolts were put in and no further trouble has been experienced from this cause. In this case it would have been better to have used smaller bolts placed closer together.

An exactly similar case occurred on a large freight steamer in which the boilers were fitted with the Howden system of forced draft. In a very few months after being placed in commission the sheets in the back connections bulged as related in the former instance, and the trouble was remedied in the same manner, by placing extra bolts in the center of the square between the regular bolts. In both of these cases this was done before the sheets had bulged to any considerable extent. The writer is of the opinion that the space between the sheets and the back heads of these boilers was too narrow, particularly where forced draft was used. It stands to reason that when the hot fire strikes the sheet it forms steam rapidly, and unless there is ample room for the steam thus formed to get up and the water to flow down, the sheets will become dry and overheated.

In another case of boilers fitted with forced draft the two furnaces in one came down without any apparent reason. No oil was used in the cylinders of either main or auxiliary engines, and the boiler was as clean inside as the day it was built. The furnaces were pumped back in place, but in a short time came down again. There was no break in the rows of tubes in these boilers, being spaced about 4 inches apart horizontally, with about 12 inches space between the sides of the shell and the end row of tubes, and the bottom row of tubes was just 4½ inches above the top center line of the furnaces. The only reason that could be assigned for the coming down of these furnaces was that the fierce heat of the fires under forced draft changed the water into steam faster than it could flow down to the furnaces, and they became dry and overheated. New furnaces were installed and the bottom rows of tubes removed, being replaced with small stay rods to brace the tube sheet, and so far there has been no further trouble with these furnaces.

All marine engineers are conversant with the fact that a boiler built by one builder will steam considerably freer than a boiler of the same size built by another builder. The reason for this can only be in the design. A slight difference in the arrangement of the tubes in a boiler materially affects the circulation, and in that way affects the steaming qualities. A couple of inches difference in the distance from the top of the furnaces to the grate bars will make considerable difference in the combustion of fuel. In one instance that came to the writer's attention a boiler in a tugboat on her trial trip would hardly make steam enough to keep steerageway on the boat. The owner naturally refused to accept her, saying that he contracted for a *steam* boat, and she wasn't that by any means. At the suggestion of a practical marine engineer, who was on the trial trip as a guest, the grate bars were lowered 4 inches, and on the second trial trip the boiler furnished ample steam with the engines running wide open. This was a clearly demonstrated case of faulty design, although on the next boat that these builders turned out the same defect was found in the boilers and remedied in the same manner. It is rather curious how designers stick to their theoretical ideas in the face of practical demonstration of their faultiness.

Another defect in boiler design that is altogether too common is restricted steam space. In many boilers the area of water level and the steam space above the water level is so restricted that the release of globules of steam at each stroke of the engines carries water over into the engines with it, due to the fact that the area of water surface is insufficient to allow the steam to escape from it without violent disturbance of the water. It is rare, indeed, where the top row of tubes could not be dispensed with, thus increasing the steam space, and adding the heating surface thus done away with by lengthening the

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boiler a foot or so, or slightly increasing the diameter, in many cases doing both.

The writer makes no claim to being an expert boiler designer, nor is this article written with the expectation that boiler designers will adopt any of the ideas suggested herein. Neither is he foolish enough to think that theory does not work out in practice, as so many practical men assert, but he does know that in many cases practice proves theory wrong, and these instances of experiences in practice prove the truth of this statement. J. S.

Boilers and Scale

Scale is the marine engineer's bugbear. More damage is done to boilers by scale than is usually realized. All engineers know what scale is, how it is formed, and the usual means taken to keep it at a minimum. The quantity and quality of the scale depend entirely upon the chemical composition of the feed water. The importance of scale has been brought home to engineers in the same proportion as the working pressures have increased in late years, owing to the higher temperatures. Water that has been made from steam in the condenser does not form any more scale, and so it is advantageous to prevent the loss of any of this water through steam leaking at pipe connections or stuffing boxes. All of this lost water has to be made up with fresh water from the reserve feed tanks. It is, of course, impossible to keep enough water in the boilers without using a little make-up feed each watch, but it should be the object of all careful engineers to keep the quantity of this make-up water as small as possible.

About a year ago I had the opportunity of inspecting the boilers on one of the largest oil carriers in the Pacific. These boilers had been giving us a great deal of trouble and had caused a great loss of time to the owners. The pressure system of oil fuel burning had recently been installed in the vessel with good results. It was found that on the run across the Pacific it was not necessary to stop in Japan for coal and the stays in port were reduced to the small number of hours required to discharge an oil cargo, but hereon hangs the tale.

The first trouble after installing the oil fuel burners was a leaky back tube plate. This was repaired in port by rebeading the tubes. The cause of this trouble was laid to the burners, insomuch as it was thought the long flame and high-pressure caused too great a temperature in the combustion chamber. The bridges in the furnaces were built up. This seemed to help matters, but didn't overcome the trouble. The next voyage the combustion chamber backs at the furnace level showed weepings about the stays, and it was decided to build up the back of the chamber with a good lining of fire brick up to the level of the furnace crowns. Upon the vessel's next arrival in San Francisco a newer type of burner was installed which, on a twelve-hour trial, showed still better results than the old ones.

With this type of burner it was considered desirable to take out the extra bricks in the combustion chambers and reduce the bridge to its normal proportions. On the boat's arrival in the East we received word that the backs of all combustion chambers were badly buckled and one had cracked between stays. This was at Hong Kong, a port well known for good boiler makers, and it was decided to make the necessary repairs at once.

The chamber backs were straightened and extra screw stays put in where it was thought they were needed. The crack was welded up by the acetylene process successfully. This was a pretty expensive job and we hoped would last until it was time for reboilering the vessel.

Upon reaching San Francisco after a run to Calcutta, the chamber backs were again in bad shape, the stays were leaking and all the nuts on the chamber tops were burnt off. The back tube plate was again leaking and we had another big boiler job on our hands. The ship's staff was convinced that all the trouble was due to the impinging flame and the high temperatures caused thereby.

At this time I made a thorough examination of the boilers. They had just been dried out, but as yet no work had been done. After a close inspection I decided that all our trouble had been due to an accumulation of scale. The tube ends and stay ends had large deposits on them. The chamber backs were covered with a half broken off coating of scale where the most severe buckling had been, although a lot of this had been removed in making the repairs in Hong Kong. The rear tube plate was also pretty well covered. At first I could not understand how this condition came about. The boilers were small and of a design not adapted to easy cleaning, but the scaling had always been done very satisfactorily by the Chinese scaling firms.

Upon investigation I found the causes to be two in number. The first was that, owing to the oil fuel, the hours in port were very much reduced, and therefore the scaling had to be done in a great hurry. Also, owing to the rush with which the overhauling on engines and boilers had to be done, the engine staff had been forced to neglect somewhat the inspection of boilers after scaling had been done. The second reason was that boiler scaling had very recently become the object of cut prices and keen competition among the Chinese firms. The low figures in vogue necessitated the hiring of smaller boys than usual, and fewer to a job. Scaling was done day and night, as a rule, with one going on all day and another at night, but under the present circumstances the same poor boys were doing a twenty-four-hour shift. Boiler scaling is never done better than is required by the engineer in charge, and when time is so limited and the chipping boys of such a young age, it is mighty hard to get a good job. The oil fuel boats also suffer because they do not have a large gang of firemen that can be sent into the boilers to chip.

The above incident is one of the many that have caused big boiler repair bills, and is offered as a suggestion to all engineers to be sure it is not scale before looking further. The vessel in question was retubed and the unfairness in all plates removed. Since then we have been getting good scaling jobs and have had no trouble to speak of.

F. K. R.

Salt Water in the Fireroom

My experience seems to show that the use of salt water in the firerooms, particularly in the ashpans and on the floor plates, is entirely too common. In many ships that I have been on, it seems to be the established custom to try to keep the material in the ashpans of watertube boilers in a wet condition at all times. I have tried to discover why this was done, but have only been able to get a vague answer that it saved the bottom of the ashpan from burning out.

A little reflection will convince even the most ardent advocate of this method that such a statement is entirely without foundation. In ordinary coal-burning boilers very little heat is radiated downward because the grate bars are partially in the way and there is usually a layer of more or less burning material just on top of the bars. If there is a good draft, practically no heat should get to the bottom of the ashpans by convection. As an additional safeguard, the ashpan usually has a considerable quantity of ashes covering its bottom. The temperature

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of the ashpan bottom will never get to such a point that it is in danger of collapsing. All water poured into the ashpan is therefore not only useless, but quite undesirable as well.

The water, after evaporating, passes up with the draft of air, tends to cool the incandescent coal with which it comes in contact, absorbs a certain amount of heat, and then passes off with the gases of combustion. The only real thing the water has accomplished is to furnish a means for carrying a large number of British thermal units up the smokestack. In addition to this, it keeps the ashpan in a damp condition and aids corrosion.

From all that I can learn, this system of having wet ashpans at all times is a relic of the days when wooden hulls were in common usage. There might have been some logic in it then, as at that time it was possible to char or even to set fire to the vessel's timbers.

It seems to be the general custom to use salt water on the fireroom floor for three purposes; first, to wet down incandescent coal when hauling or cleaning fires; second, to dampen coal before firing; and third, to wash all the fine ashes and dust into the bilges.

A certain quantity of water is necessary in the first case, since it seems almost impossible to do this work without quenching the live coals.

In the second case—that is, for wetting the coal before using—the use of water cannot be recommended unless the coal is very fine and dry. In such a case it may be possible to effect a greater saving by keeping the small particles of coal in the furnace, instead of letting them go up the smoke stack with the draft, than is lost through the heat required to evaporate the water and highly heat the water vapor. Contrary to much fireroom opinion that I have heard, the water does not assist the coal in burning in any way. It retards the burning of the coal in every case. The fuel must be dried before it can be burned, and to dry the coal requires heat—uselessly expended in nearly all such cases. The water which was added to the coal goes off as very highly heated water vapor, and carries with it just that amount of heat necessary to effect the transformation that it undergoes.

In the third case, that of washing everything into the bilges, the practice is extremely bad. The ashes and coal get into the strainers and stop up the drain lines, while the water lodges between the floor plates and the supporting angle irons and there causes rapid corrosion. An old broom will give much better results in the long run.

The writer has had a little experience with the use of water by the men on watch below. In this case a small blowout occurred (on a small tube boiler) at the junction of the auxiliary steam stop and the boiler drum. The blowout was not very bad, but it necessitated the immediate hauling of the fires. This work was particularly hot, as the fires were heavy and were burning brightly when the accident occurred. Of course the ever-present hose was brought into service to quench the live coals drawn out. Everything was done in a proper manner until the man behind the hose decided that it was absurd to haul all of those hot coals out into the fireroom when they could just as well be quenched on the grate. So he turned the stream into the fire spaces of the boiler, where the cold water came in contact with quite a number of hot tubes. This man was almost immediately relieved of his particular job, otherwise the boiler would have been ruined.

It was remarkable to see what damage that little stream of water did in a few seconds. Several tubes split and many more were injured, but, fortunately, the pressure had been taken off the boiler by this time, so no serious accident occurred.

The repairs to this boiler took the ship's force several days. I believe, in all, about forty tubes were either cut out or plugged. It was a continual process of plugging all leaky tubes, putting on the hydrostatic pressure, having one or two more tubes split, then repeating the whole process. In the end the boiler was made tight and put into service once more, but I imagine that there must be some weak tubes in that part of the boiler even to-day.

It is on account of having had a few such experiences myself, and having heard of countless others of a similar nature, that I am led to the conclusion that all engineers would do well to keep the consumption of salt water in the firerooms at its lowest practicable limit.

W. W. B.

BURNING OF THE LUMBER STEAMER MONTANA.—The wooden lumber steamer *Montana*, owned by George A. Kotcher, of Detroit, Mich., an old-time vessel built in 1872, with a carrying capacity of about one million feet, commanded by Captain George C. Burns, was destroyed by fire in Lake Huron off Alpena, Mich., September 7. Her loss will add something to the difficulties that owners of wooden vessels find in obtaining fire insurance on their ships. Many wooden vessels have been put out of commission on the Lakes through inability to obtain insurance, and a number of vessel owners have formed insurance pools to carry their own risks. The crew of the *Montana* returned to Detroit, although their personal belongings were lost on account of the rapid spread of the fire.

CRUDE OIL IN PERU.—Most of the crude oil of the Lobitos-Negritos fields in Peru, which are controlled by the Standard Oil Company, is shipped to California to be refined and later returned to supply the markets of Peru, Bolivia and Chili with petroleum fuel. About 50,000 tons are annually returned to Peru, the larger part of which is used by the oil-burning steamers of the Peruvian Steamship Company. At both Callao and Paita are large storage tanks equipped with modern facilities for rapidly handling the oil. A fleet of tank steamers is employed in transporting the products of the Lobotis fields, the registered production of which amounted to over 331,000 tons in the seven years prior to last year.

NEW SOUTHERN PACIFIC FERRYBOAT.—The ferryboat *Alameda*, built in the Southern Pacific Company's shipyard at Oakland, Cal., was recently placed in commission by the Southern Pacific Railroad Company between San Francisco and Oakland Pier. The *Alameda* is a steel vessel 292 feet 4 inches long, 75 feet 4 inches beam over guards and 15 feet 3 inches deep, propelled by side wheels driven by engines developing 2,500 horsepower, which give her a speed of 19 knots. Steam is supplied at a pressure of 200 pounds per square inch by four Babcock & Wilcox watertube boilers fitted for burning coal.

NAVIGATION FROM NEW ORLEANS TO ST. PAUL.—The first cargo boat of any kind to make a through trip from New Orleans, La., up the Mississippi River to the head of navigation at St. Paul, Minn., was the self-propelled barge No. 5 of the Alabama & New Orleans Transportation Company. The cost of operation of the barge was so low that freight was accepted on the initial trip at 75 percent of the rail rate to the same point.

JAPANESE COAL SHIPPED TO THE UNITED STATES.—Japanese coal is finding a ready market in all the ports of the Orient. The demand has rapidly increased of late, having extended to the west coast of the United States. So far this year San Francisco has received $500,000 (£102,500) worth from Nagasaki.

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Marine Articles in the Engineering Press

New Naval Vessels for France, Spain, Canada and Russia—Annual Meeting of the Japanese Institution of Naval Architects—Economy of Steam Consumption

Types of Modern Steam Colliers.—By Maxwell Ballard, A. M. I. N. A. Treating the subject from a structural standpoint, it is noted that the design of the ordinary collier of the present day is based on the constructive ideas of the previous generation and that the tendency of shipowners is to regard such existing types as final so far as design is concerned, and to devote all their attention to the perfecting of the details of equipment. An outline of the main conditions and requirements that should be embodied in a successful steam collier and an analysis of the advantages and disadvantages of existing types as to the requirements outlined form a good comparative study. The results are rather discouraging, however, since no existing type is considered successful. The author then describes the Arch patent type of collier, which is the latest design offered to shipowners interested in the coal trades, and possesses considerable advantages over the ordinary types and the claims for improvements have been acknowledged as a result of actual experience. 1,600 words. 5 illustrations.—*The Shipbuilder,* July.

Lifeboats in Marine Disasters.—The recent clamor of the public and authorities for lifeboats on passenger ships equal to the full complement is in this article pronounced an exaggerated demand, which loses sight of more important considerations over one less valuable. Lessons are drawn from three marine disasters—of the *Elbe* in 1895, of the *Titanic* in 1912 and of the *Volturno* in 1913—to show that wireless telegraphy, combined with the most efficient watertight subdivision, would prove of far more value to save all passengers than even the very fullest boat equipment could do. It is given as the best consensus of nautical judgment that few more boats are needed on an efficiently subdivided and wirelessly equipped ship than there are boat crews available and able to handle them. It is considered that boats should fill only a temporary service, acting as ferries between the injured or burning ship and approaching relief ships or large drifting floats or rafts launched from the ship in addition to the boats with less difficulty and danger. Such life rafts, perhaps of the self-launching type, are considered the best auxiliary to an efficiently manned but limited fleet of lifeboats, which together would give enough time for an efficiently subdivided hull to keep afloat until the wireless calls bring relief ships to the spot. 7,060 words.—*Schiffbau,* June 10.

The French Destroyers Bisson and Renaudin.—A description of the torpedo boat destroyers *Bisson* and *Renaudin,* recently taken over by the French Admiralty, shows some interesting features. Both vessels are 256 feet 2 inches long between perpendiculars, 25 feet 8 inches beam, 16 feet 9 inches depth, with a draft aft of 9 feet 9 inches, giving a displacement of 715 tons. The hull in each case is of Siemens-Martin steel, having a breaking strength of 38 tons per square inch with an elongation of 15 percent. With the exception of the stem, the hull is clincher riveted throughout. The keel is of teak, 10 inches by 5 inches in cross section. The armament consists of four 18-inch torpedo tubes arranged in pairs above the turbine rooms. There are also two 4-inch quick-firing guns, one forward and one aft, and four 2.5-inch guns at the sides. The shells are conveyed by electric hoists from the ammunition rooms, which are ventilated by electric fans. The main engines consist of two Brequet marine turbines, designed to run at 630 revolutions per minute and to develop 14,500 shaft horsepower with a steam pressure of 171 pounds in the steam chest. A special feature of the machinery is the application for the first time of a new invention of the makers of the turbine. This is the *Ejectair Brequet,* and was used for the first time on the *Renaudin.* It is a dry-air pump which it is said has no moving parts, and of which the simplicity, safety and stability made a considerable impression on the technical men who saw it work. The article includes a description of the éjectair as used with both surface and jet condensers, showing the principles involved in its operation. In the official trials the *Bisson* made 31.98 knots and the *Renaudin* 31.267 knots over the measured mile. 1,000 words. 3 illustrations.—*The Engineer,* June 5.

Methods of Securing Economy in Steam Consumption—Superheating and Improved Condensing Apparatus.—By Lieutenant Commander H. C. Dinger, U. S. N. A few brief remarks on superheating, together with comparative figures and calculations on efficiencies with and without superheating, show that there is an enormous gain in economy that may be secured by the use of superheat on marine boilers. Commenting in this way and on the difficulties that may be encountered, together with actual results in practice, the author of this article leaves little doubt as to the advisability of using superheat. In connection with the general features of superheaters the various types are described in detail, first with watertube boilers and then with Scotch boilers. The principles of operation and construction details are described for such boilers and superheaters as Babcock & Wilcox and Foster superheaters, Lovekin superheater boiler, with a list of advantages for the use of the Lovekin superheater on Scotch boilers. The subject of superheaters in express watertube boilers brings up questions of necessary economy on vessels of the destroyer class and the feasibility of the use of reaction turbines with superheat. The superheating in connection with the Yarrow boiler is extended to include an improvement in steam turbine installations for superheating exhaust or receiver steam. In Scotch boilers the usual system is fitted by putting U-tubes into the boiler tubes at the smoke-box end and connecting them to steam headers. This principle is carried out very successfully in the Schmidt fire-tube superheater as manufactured by the Locomotive Superheater Company, New York. Separately fired superheaters have been used to some extent, especially in Germany, but it would appear that these add greatly to the complication and no advantages are apparent to warrant their use. The same argument that held for the use of superheat holds for the use of a high vacuum, since in using superheat the initial working temperature is increased and in using a high vacuum the final temperature is decreased. Further, there seems to be no excuse for using a vacuum as low as 27 or 28 inches, when careful operation will give 29 inches, with a considerable gain in economy. Probably the most important consideration for careful operation is air leakage and its elimination. The author explains this thoroughly and takes up the subjects of air treatment, baffling kinetic effect, relative location of condenser and air pump, circulating water and condensing surface re-

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quired. In connection with the last-named sub-topic a table is given on some recent results for the amount of water condensed per hour per square foot of cooling surface at temperatures of circulating water and inches of vacuum obtained. After discussing the type of drive for circulating pumps the different types of condensers are described. Such types as the Westinghouse marine-service condensers with a Leblanc air pump and the Spiroflo surface condenser present many interesting features. Descriptions of the Hydroflo dry-air pump and the Weir dual air pump are then given and followed by various concluding remarks on other late installations, kinetic jets, most acceptable systems, position of condenser referred to engine, water agitating devices, cleanliness of cooling surface, protecting tubes from steam blast, testing condensers for leaks, corrosive action and a discussion on salt leaks. 18 illustrations. 17,000 words.—*Journal of the American Society of Naval Engineers,* May.

Recent Developments in Marine Propulsion.—Although in the form of an abstract of a lecture, delivered by Professor W. H. Watkinson at the Liverpool University, the article outlines the development of marine propulsion from the time of James Watt, and includes comparisons and actual statements of accomplishments in a clear and concise manner. No notable improvements have been made in boilers in recent years, and it is stated that the watertube type is taking the place of the Scotch boiler throughout naval work, but that the Scotch still remains in the merchant service. The greater possibilities of the internal combustion engine for marine propulsion necessitate considerable attention to this later development and much comment is made on its future, more from a standpoint of fuel than of its mechanical possibilities. 2,800 words.—*The Engineer,* August 7.

Limitations of the Submarine.—Granting that the submarine is a serious factor and one to be given a prominent place in any balancing of naval forces, and that the type will increase in size, power, speed and offensive capacity, it is doubtful that it will become a still more serious factor in the future. Its limitations in action are defined, and it is explained how these are imposed upon it by reason of the very qualities it possesses as an attacking force. The article argues clearly that the battleship is not doomed because of the submarine, due mainly to the limitations outlined of the latter, and that it is only a new method of attack that must be met with by other methods of defense and that provision of submarines must be ample to match those of possible foes. 1,900 words.—*The Engineer,* July 31.

Russian Naval Expansion.—The report that the Duma had just voted the expenditure of $48,000,000 (£10,000,000) for the construction of warships for the Black Sea fleet is confirmed and it is intimated that a second extraordinary expenditure will be involved in a second naval programme amounting to about $288,000,000 (£60,000,000). This does not include the sum of $131,500,000 (£27,400,000) provided for this financial year, but must be added to it. The author compares these figures with the outlay in previous years for the development of the Russian navy, and traces the attempts made for the reconstruction of the Baltic fleet particularly. In concluding, it is pointed out that the cost of constructing a battleship is declared to be double in Russia what it is in Germany or Great Britain, and that if such is true it is not surprising that English co-operation is secured in the development of the Russian navy, and that very large expenditures are involved in each naval programme which is submitted to the Duma for approval. 1,500 words.—*The Engineer,* June 19.

Foundations for Largest Ore-Shipping Dock in the World.—Foundations for the fifth and latest ore-shipping dock of the Duluth, Missabe & Northern Railway Company at Duluth, Minn., are 2,146½ feet long, 64 feet wide, and contain 24,225 cubic yards of concrete. The dock is the largest of its kind in the world and has a storage capacity sufficient to load fourteen vessels with an 8,000-ton cargo. On the inside of the dock the concrete capping the 14,600 round piles is 4½ feet thick, increasing by three 1-foot steps to the outside, where it is 7½ feet thick. U. S. steel interlocking sheet piles 40 feet long were driven 6 inches below low water around the entire dock between the two outer rows of round piles, to retain the sand pumped in from the bay to within 18 inches of the low-water mark. Steel columns for the dock rest on 395 concrete pedestals or piers 5 feet square on top and spaced on 12-foot centers. Two concrete handling plants were used, the first being mounted on double flange wheels running over rails 23 feet apart laid on 8 by 12 inch crossties 26 feet long, supported by capped piles. This track was removable, and as its support was under water relaying was accomplished by floating the section passed over around the plant to the piles ahead. Concreting was begun in August of last year and completed in November, and work on foundation started in February. 3 illustrations. 1,100 words.—*Engineering Record,* August 29.

Barge Canal Terminals.—By J. A. O'Connor. The improvements of the canal system of the State of New York by the construction of the Barge Canal raised the vital question of providing adequate terminal docks which would be controlled by the public. The design and construction of these docks have brought forth a number of interesting problems for the engineer, since in nearly every case construction must be carried on in or under water. Several types of docks have been designed to meet the conditions found at the various locations. At the site of the terminal dock at Albany an old timber bulkhead existed along the 1,500 feet of river front to be occupied by the proposed terminal dock. The bulkhead line as established by the United States Government extended only a few feet outside of the old dock, so that to construct a gravity wall would have necessitated expensive excavation of the old dock. A type of reinforced concrete sheet-pile bulkhead, with heavy concrete and steel lies anchored in concrete piles driven back of the old dock, was finally adopted. At the site of the Troy terminal an old timber dock must be removed to allow the construction of the new concrete wall about 960 feet long. The wall itself is of the standard gravity type, and it is proposed to construct a movable gangway at the north end of the dock as a means of unloading small boats. There will also be constructed a large storehouse at the northerly end which will have track connection with the adjacent railroad terminals. It is also proposed to provide freight-handling machinery which will transfer freight directly between freight cars and barges, as well as between barges and the freight house. In designing the dock wall of the terminal at Schenectady the nature of the foundation material encountered favored the construction of a concrete wall and slab resting on wooden piles. At Rome, where the foundation was gravelly, a sheet steel bulkhead was constructed, topped by a narrow concrete wall, and the entire bulkhead fastened with large steel tie rods, spaced 6 feet apart and anchored to a continuous line of wooden piles 40 feet back of the bulkhead. The plan for improving the harbor of Erie Basin, the western terminus of the Erie Canal, contemplates the removal of the southerly end of the breakwater and all

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old piers, together with sunken wrecks, to provide a depth of water 23 feet in the basin. Two new piers and 300 feet of dock wall will be constructed by means of rock-filled timber cribs topped by a continuous concrete dock wall 8½ feet high. A portion of the dock wall lies wholly on land, and it was decided to construct this portion of sheet steel piling capped by a concrete wall 8 feet long by 12 inches thick, and to be tied back to a reinforced concrete anchorage. Several wrecks and a large amount of earth excavation have already been removed from this harbor. 5 illustrations. 2,200 words.—*Engineering Record,* August 29.

The Armament of the Spanish Battleship Espana.—The first of the new battleships for the new navy of Spain has just completed the trials of her gun mountings, and these have been entirely satisfactory both as to guns and mountings and to the ship's structure. The *Espana* is 435 feet long, 78 feet 9 inches beam and displaces 15,460 tons at a draft of 25 feet 6 inches. Both vessel and machinery were built at Ferrol Dockyard. The machinery is of the Parsons turbine type with Yarrow boilers. The vessel is designed for a speed of 19¼ knots at 15,300 shaft horsepower. The main armor belt is of 9-inch armor and the vulnerable parts of gun positions have 10-inch armor protection. There are eight 12-inch, twenty 4-inch, two 3-pounders, two 3-inch guns and two rifle-caliber Maxims. The 12-inch guns are mounted in pairs in barbettes, while the 4-inch guns are mounted in casements. The 3-pounders are semi-automatic quick-firing on upper deck mountings. The 12-inch capped projectiles penetrated 13.3 inches of K. C. plate at 10,000 meters range, while the 4-inch uncapped projectiles penetrated 4 inches at 3,000 meters. The gun trials were very satisfactory and the final test was a salvo of all guns on the port side of the ship, in which the firing was absolutely instantaneous, and a thorough examination afterwards showed not the slightest damage to the ship's structure, even though the guns were at maximum elevation to make it most severe. Besides a description of trials and results, the article includes detailed descriptions of the guns, together with mountings, breech and loading mechanisms, ammunition handling, etc. 8 illustrations. 4,250 words. —*Engineering,* July 31.

Japanese Institution of Naval Architects.—Of the various papers read at the meetings of this institution at Tokyo, three are given as abstract and one in full in this article. *The Salvage of the Umegoka Maru*: This ship was sunk in the Straits of Moji and lay on her port side on hard sand in 6 to 9 fathoms at mean tide. The operation involved getting the ship on an even keel and keeping her so while raising her bodily. In order to get the ship on a level keel, seven watertight sections were made between the shelter deck and boat deck, and these pumped clean to obtain buoyancy. A system of tripods was fitted to the starboard side, to the tops of which were attached a series of wire ropes and tackles, three in number, and anchored some 1,200 feet from the ship. The fulcrum for the system was obtained by two anchors on the opposite side of the ship. The falls from the tackles were led to the salvage steamer *Arima Maru* and to a large rock-breaker, which were equipped for hauling, and these vessels again were connected to the *Umegoka Maru.* After the vessel was turned over to a level keel in the upright position a 242-foot cofferdam was constructed and made watertight, and by carefully drawing from the different connections through the various pumps, the vessel was brought bodily to the surface on a level keel. *A Self-Recording Strain Meter*: The instrument described in this paper is an outcome of Mr. Stromeyer's arrangement made self-recording, and applicable to launching observations in the first instance, but also to any recording of stresses at sea, etc. The principle of operation of the instrument is to magnify by an increased leverage the compression or elongation between two points and to record this continually on a smoked paper drum revolving at uniform speed. The time and distance run by the ship are also recorded simultaneously. The increased leverage is obtained by means of two blocks capable of sliding by each other and having grooves cut in their faces, between which is inserted a knife-edged hard steel pin carrying an aluminum pointer with a light pen at its end. Various launching stress curves are given, showing how the results are plotted. *Ramsbottom Packing Rings*: This paper describes experiments on the distribution of pressure round the ring; when the inner circle is concentric with the outer; when it is eccentric; and when the rings are turned once only; when they are tightened after the first turning with a strong belt and returned. The apparatus used consisted of two cast iron straps turned to a true circle with inside diameter of 6¼ inches; a ring having 6½ inches outside and 6 inches inside diameter was cut into a number of pieces or blocks. The Ramsbottom ring was inserted inside the blocks and the whole enclosed by the two straps, which were screwed up. The pressure at each block was then found by ascertaining the force required to move each block. In addition, the author suggested a modified ring with the inner surface formed of two half circles differing slightly in their eccentricity from one another as well as from the outer surface. *Safety at Sea*: By Professor F. P. Turvis, Tokyo Imperial University. The author discusses several questions that in his opinion have either been left untouched or have not received sufficient attention by the International Convention on Safety of Life at Sea. His first question is whether the connection between the inner skin and the web-frames should not be rather slight, the inner skin being stiffened by independent frames; injury to the outer skin and the web-frames would then not necessarily involve any part of the inner skin. Another important question raised by the author is the practicability of transverse bulkheads without watertight doors, and he cites two cases in which each stokehold has its own bunkers and communication along the level of the stokehold floor is therefore not urgent. Various other questions were discussed dealing with watertight decks and the operation of watertight doors, etc. 15 illustrations. 3,300 words.—*Engineering,* July 24.

The Sub-Division of Ships.—In a discussion outlining various considerations of the Convention for the Safety of Life at Sea, the author reviews some of the important decisions arrived at by the committee on sub-division. The broad basis on which the whole question of sub-division was considered and which includes those of bulkheads, double bottoms, watertight doors, etc., was that ships be as efficiently subdivided as possible, having regard to the nature of the service for which they are intended. The regulations regarding sub-divisions are entirely independent of other sections of the conference report, and have no connection with safety of navigation or life-saving appliances, each of which is to form its own ideal. In conclusion the author emphasizes the fact that the apparent incompleteness of the conference rules on construction is mainly due to the magnitude and complexity of the subject of sub-division. What, however, has been clearly laid down is the substitution of a scientific and a logical method of sub-division for the *rule of thumb* systems that have long since outgrown their range of applicability. 3,000 words.—*The Engineer,* June 5.

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The Port of Antwerp.—An outline of the past developments of the port of Antwerp, which is said to have existed from prehistoric times as a port for loading and discharging sea-going vessels, forms an introduction to the main part of the article describing the improvements now being made by the municipality. The recent improvements involve the diversion of the River Schelde, eliminating all sharp bends and making the diverted part of uniform width. 4,250 words. 1 illustration.—*The Engineer,* June 26.

Canadian Customs Twin Screw Cruiser Margaret.—The vessel was designed for custom patrol work on the Atlantic coast and built by Messrs. John I. Thornycroft & Company, Ltd., at Southampton. With a ram bow and cruiser stern the *Margaret* is 200 feet overall, 185 feet between perpendiculars, 32 feet molded breadth and is limited to a draft of 10 feet 6 inches when carrying 175 tons. The hull is stiffened to resist ice and the shaft is housed in the hull for its entire length. The propelling machinery consists of two sets of vertical reciprocating, triple expansion engines, having a combined indicated horsepower of 2,000 at 180 revolutions per minute. Each engine has an independent steam-turning engine and alternative hand gear. The condensers are of the surface type and receive circulating water from two independent centrifugal pumps driven by vertical open-type engines. Steam is supplied at 220 pounds per square inch working pressure by two water-tube boilers, each having 3,297 square feet of heating surface and 60.4 square feet of grate area. The bunkers are made oil tight and have a capacity of 200 tons, giving a range of nearly 2,000 miles at full speed, and about 4,000 miles at an economical speed. That the vessel is very completely fitted up is seen from a description of auxiliaries and equipment besides the comfortable accommodations and conveniences for officers, crew, etc. There is a large wireless telegraphy instrument and an electric installation which, in addition to supplying current to the wireless and general lighting, supplies current to a 24-inch projecting searchlight fitted in the crow's nest on the foremast. On the forecastle deck there are two 6-pounder quick-firing guns of the Vickers type, having telescopic sights. The boat is rigged as a fore-and-aft schooner, having two pole masts, the lower part of each being made of steel and the upper or topmasts of wood. The foremost is fitted with a staysail and the mainmast with a staysail and trysail for use in cases of emergency. 28 illustrations. 2,400 words.—*Engineering,* September 4.

Ice-Breaking Railway Train Ferry Leonard.—Messrs. Cammell Laird & Company recently completed at their naval works at Birkenhead an ice-breaking steam railway train ferry for the Commissioners of the Transcontinental Railway of Canada. The vessel is designed for the special service of transporting passenger railway trains or freight trains across the St. Lawrence River at all seasons of the year between Quebec and Levis. Designed to carry a train of 1,285 tons, the *Leonard* is 326 feet long, 66 feet 9½ inches extreme breadth, with a mean draft of 15 feet. The vessel is of the twin screw type with an ice-breaking propeller at the forward end. The special feature of the design is the elevating car deck, with a double track, whose height can be varied to suit the tidal range of the St. Lawrence River. This deck is arranged above the main deck of the vessel, and is carried on ten transverse girders, the ends of which each rest on a large nut, and the revolving of a vertical screw causes the nuts to raise or lower the deck to suit the various tide conditions. These vertical screws are hung from ball-bearings supported on strong columns stayed by lattice buttresses and bracing against fore and aft movement. The load on each of these columns is distributed to the keel of the ship by means of specially strong-braced struts in way of each column below the main deck. At each end of the tidal deck an adjustable hinged gangway is suspended by means of triple purchases from struts fixed on the deck, and each gangway is fitted with a special electric motor for raising or lowering it. The machinery for raising or lowering the tidal deck is placed amidships and is of special construction throughout. The engine is of the four-cylinder, high-pressure type, driving through double helical spur-wheels, a second motion shaft running athwartships. At each end of this shaft mitre wheels are arranged for driving the fore and aft line shafting arranged on both port and starboard sides of the vessel. At equal distances along this shafting, worm and wheel gearing is fitted for turning the vertical lifting screws, which are driven through a loose forged steel sleeve and sliding key arrangement fitted into the boss of the wheel. A promenade is arranged all around above the tidal deck and carries a bridge platform at the forward end with pilot house and chart room. Accommodations for officers and crew are arranged below the main deck forward. The propelling machinery is of a design fitted by the firm to a large number of merchant ships and consists of two sets of triple expansion, surface-condensing, reciprocating engines designed to run at 120 revolutions per minute. The propellers and shafting have been made specially strong to withstand shock from striking ice. At the forward end of the vessel a set of compound surface-condensing engines is fitted, driving a nickel-steel propeller for clearing ice at the bow. Steam is supplied throughout by eight single-ended boilers working under natural draft and at a working pressure of 165 pounds per square inch. 9 illustrations. 1,600 words.—*Engineering,* August 14.

Oil-Carrying Steamers.—Comparing the recent *San Isidoro,* one of a large new fleet of oil-carrying steamers for the Eagle Oil Transport Company for the oversea conveyance of Mexican oil, the article traces the growth in size of oil-tankers and particularly the economy resulting from increased capacity. This growth is very strikingly shown by the help of tabulated results taken from actual practice. Following this, as an example of the present day practice in this type of vessel, is a complete description of the *San Isidoro.* This vessel was built on the Isherwood system of longitudinal framing at the yards of Sir W. G. Armstrong, Whitworth & Company, Ltd., who have completed more than 100 vessels of this class. She is 548 feet long overall, 66 feet 7 inches extreme breadth, and has a mean draft in service of 28 feet, with a deadweight carrying capacity of 12,350 tons. The propelling machinery consists of one quadruple expansion vertical reciprocating steam engine, and was supplied by the North-Eastern Marine Engineering Company. Steam is supplied at 220 pounds pressure per square inch by four Scotch boilers fitted with Howden's system of forced draft. The Wallsend Howden oil-fuel-burning installation was fitted on each boiler by the Wallsend Slipway & Engineering Company, Ltd. The bulk oil is carried in twelve tanks between forward and after cofferdams with the machinery space aft. The tanks are divided equally in three parts by two pump rooms, forming practically two auxiliary cofferdams. There is also supplied a means for carrying miscellaneous cargo if the specific gravity of the oil should be low. The pumps for oil fuel are fitted in an isolated pump room, thus keeping the boiler room as clear as possible from any leakage from pipe joints, etc. 14 illustrations. 2,800 words.—*Engineering,* August 7.

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New Books for the Marine Engineer's Library

Aids to Navigation—Annual Directories—Jane's Fighting Ships for 1914—New Edition of Machinists' Handbook

RULES OF THE ROAD AT SEA BY DIAGRAM. By Charles Longstreth. Size, 4⅞ by 7¼ inches. Pages, 28. Numerous illustrations. Philadelphia, 1914: Elliott Curtis.

As a study of the printed Rules of the Road at Sea are likely to be confusing to a novice, Mr. Longstreth has illustrated by means of diagrams the International Rules and also the Inland and Pilot Rules where they add to or conflict with the International Rules. The pamphlet will aid materially in explaining to motor boat owners the rules of the road.

STATE PILOTS AND MARITIME VIRGINIA. By Charles Frederick Stansbury. Size, 11 by 8 inches. Pages, 50. Numerous illustrations. New York, 1914: The Mab Press.

As far back as 1714, an old English pilot law was passed, many of the provisions of which are incorporated in the state pilot laws of to-day. That pilots are necessary is shown by the accounts of numerous accidents which might have been avoided by means of a pilot. In this book the schooling and qualifications of pilots are explained; and in connection with these topics, maritime Virginia is discussed and illustrated to show her importance, particularly in the line of shipbuilding.

BEESON'S MARINE DIRECTORY OF THE NORTHWESTERN LAKES. By Harvey C. Beeson. Size, 6¾ by 9¾ inches. Pages, 270. Numerous illustrations. Chicago, 1914: Harvey C. Beeson. Price, $5.00.

The twenty-eighth annual number of this directory includes many articles of interest, in addition to its usual lists of vessels, engines and boilers, steamboat lines, grain elevators and marine associations, both American and Canadian, on the Great Lakes. Navigation for the season of 1914 opened very slowly, the demand for any class of tonnage being practically nil. Fully 30 percent of the lake tonnage was idle on June 25, the date on which this directory went to press, and most of the work in the lake shipyards was confined to repair work.

THE CANAL TOLLS AND AMERICAN SHIPPING. By Lewis Nixon. Size, 4¾ by 7⅜ inches. Pages, 243. New York, 1914: McBride, Nast & Co. Price, $1.25 net.

In order to give an impartial examination of the different interpretations to the meaning of the Hay-Pauncefote Treaty, the author has given within the brief limits of this book a general analysis of the treaty's provisions, together with a review of both sides of the controversy. All of the State papers that show the development of the treaty are given in full. This book is a timely contribution to the general information available on this important subject and emphasizes some points of view which might be overlooked in an attempt to make an extensive study of the voluminous addresses and papers which have been published regarding it.

AMERICAN MACHINISTS' HAND BOOK AND DICTIONARY OF SHOP TERMS. Second edition. By Fred H. Colvin, A. S. M. E., and Frank A. Stanley, A. S. M. E. Size, 4 by 6¾ inches. Pages, 672. Numerous illustrations. New York, 1914: McGraw-Hill Book Co., Inc. Price, $3.00 net.

Everyone engaged in mechanical work of any kind, whether in the shop or drawing room, frequently requires information that is not readily available. This book, therefore, has been compiled to serve as a reference book of machine shop and drawing room data, together with methods and definitions. This new edition has been thoroughly revised and contains 160 pages of additional matter. The headings under which the data are classified are as follows: Screw Threads, Pipe and Pipe Threads, Twist Drills and Taps, Files, Work Benches, Soldering, Gearing, Milling and Mill Cutters, Cold Saws, Turning and Boring, Grinding and Lapping, Oilstones and Their Uses, Screw Machine Tools, Speeds and Feeds, Punch Press Tools, Broaches and Broaching, Bolts, Nuts and Screws, Miscellaneous Tables, Calipering and Fitting, Tapers and Dovetails, Shop and Drawing Room Standards, Wire Gages and Stock Weights, Horsepower, Belts and Shafting, Steel and Other Metals, Steam Hammers and Drop Forging, Knots, Eye Bolts, Ropes and Chains, General Reference Tables, Shop Trigonometry and an illustrated dictionary of Shop Terms.

FIGHTING SHIPS FOR 1914. Seventeenth year of issue. Edited by Fred T. Jane. Size, 12½ by 7½ inches. Pages, 505. Numerous illustrations. London, E. C., 1914: Sampson Low, Marston & Co., Ltd. Price, 21s. net.

In accordance with previous issues of this well-known naval manual, the main part of the book is given over to a tabulation of data regarding the complete naval fleets of the world, arranged in the order of the naval powers of the nations. The information is given in convenient tabular form and up-to-date photographs of most of the important vessels are given, together with diagrams showing the arrangement of armor, and armament of the different types of ships. Silhouettes of different classes of vessels in all navies are given for identification purposes at sea, together with letters for signal purposes arranged on a uniform system. Part II of the book, which comprises thirty pages, contains a fully illustrated article by C. De Grave Sells, M. Inst. C. E, on the Progress of Warship Engineering. This article discusses the latest developments in propelling machinery, including the Zoelly and Belluzzo turbines, geared turbines, Niclausse, Belleville and Yarrow boilers, Diesel engines and a great many of the auxiliaries, including ventilating and refrigerating machinery. Part III, which is arranged by W. A. Bieber, is a silhouette index of the merchant ships of the world.

NAVIGATION. By Captain P. S. Thompson, F. R. A. S. Size, 5¾ by 8¼ inches. Pages, 56. New York and London, 1913: Longmans, Green & Co.

Captain Thompson explains in this book a method of finding a ship's position at sea by one observation only. Where two observations have to be taken, a delay of two or three hours must take place to allow of a change of azimuth before the computation can be completed. According to Captain Thompson's method, these disadvantages are avoided, a ship's position being fixed by an altitude of either sun, moon, star or planet at any hour of the night and at almost every hour of the day when the atmosphere and weather are suitable for observation. The entire computation can be made by a navigator in a few minutes. A well-known formula is used for finding the hour angles, two latitudes being assumed. The difference in the hour angles is taken and by proportion a correction is found which, applied to one of the hour angles, gives the correct hour angle. The true latitude is found by another proportion in which also the latitude and hour angles form the terms. Then, with these true quantities, the ship's time is easily determined and the Greenwich date and time having been noted when the observation was taken, the difference between the times gives the longitude, which together with the true longitude when laid on the chart, fixes the ship's position. Numerous examples are worked out to show the method of computation.

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ENGINEERING SPECIALTIES

Lunkenheimer Fusible Plugs

During the latter part of July, 1914, the Department of Commerce, Steamboat Inspection Service, Washington, D. C., by means of a circular letter dated July 30, 1914, File No. 1234, published a set of rules governing the construction of fusible plugs, these rules having become effective June 25, 1914. The Lunkenheimer Company recently designed the two patterns as illustrated to comply

Inside Pattern

Outside Pattern

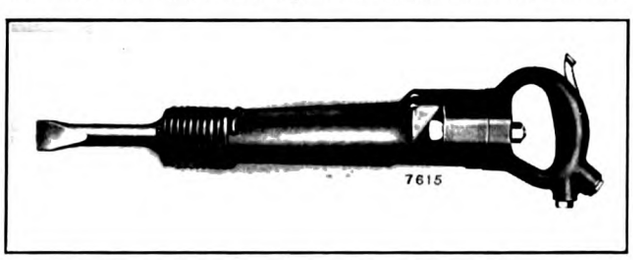
with these rules, and they were accepted by the office of the Supervising Inspector General on August 3, 1914.

Both the inside and outside patterns are made in sizes ⅜-inch to 1½ inches, inclusive. The ½-inch size and larger also comply with the boiler laws of the States of Indiana, Ohio, Massachusetts and Wisconsin. The outside pattern, in sizes ¾-inch and 1 inch, can be had in two sizes as regards the diameter of the threads, one size being slightly larger in diameter than the standard ¾-inch and 1-inch size of pipe thread, and the other still larger. The object of these two off-size diameter threaded plugs is to accommodate incorrectly tapped or retapped holes.

A New Rivet Buster

While assembling structural members, sheet metal work, riveted pipe, etc., either in the shop or in the field, it often occurs that rivets must be removed after being driven into place, in order to permit of some modification of construction or because they were improperly driven or incorrectly placed. A cold chisel and sledge is often used to knock off the rivet head, however. This method is not only slow and awkward, but may actually result in injury to the work.

Pneumatic chipping hammers are probably the handiest tools for use where a large number of rivet heads have



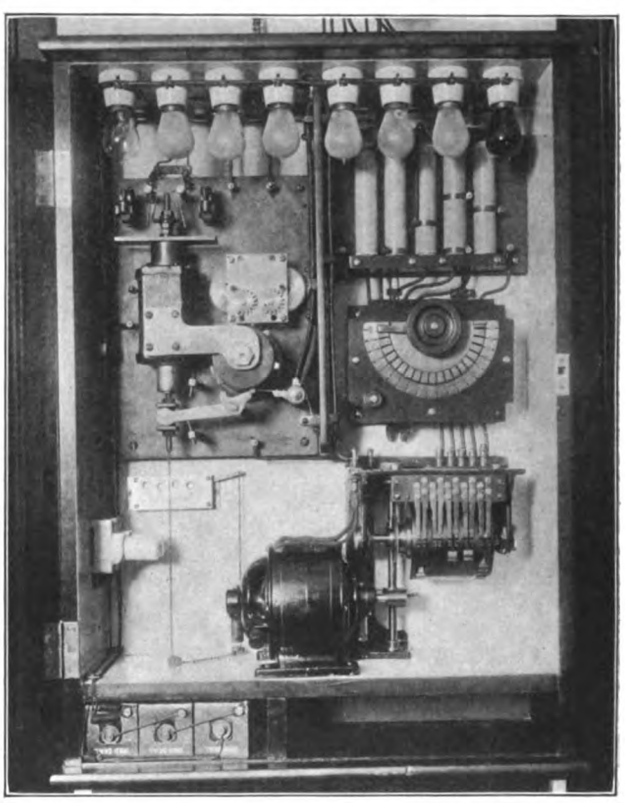
"Little David" Rivet Buster

to be removed. The common procedure with large rivets is to cut a slot across the rivet head, similar to the slot in a round-headed screw. Then with two light blows, one on either side, the rivet head is broken off with little difficulty. Where rivets must be removed only occasionally, however, the trouble of keeping a pneumatic chipping hammer always at hand for only occasional use precludes its more general employment under such circumstances.

Appreciating these conditions, the Ingersoll-Rand Company, 11 Broadway, New York City, have brought out the "Little David" rivet buster, which is made to be used with the regular line of "Little David" pneumatic riveting hammers. It is but an instant's work to remove the rivet set and insert the rivet buster in the nozzle of the hammer. The end of the device is similar to that of the regular rivet set and is designed so that it can be held in place by the safety retaining spring, which is also a recent improvement on "Little David" riveters. This safety feature, it is claimed, absolutely prevents the accidental ejection of the set or chisel while the tool is in operation. The chisel end of the buster is of a size and shape found to be most suitable for its purpose. It is also useful for removing burrs or other defects from the metal. It is of such a small size that it can be carried in the workman's pocket without inconvenience and is always at hand when needed.

Mechanically Directed Firemen

The problem of eliminating all regulations requiring the exercise of reason or judgment and mechanically directing ignorant firemen has been solved by the Bonner Automatic Timer, an electrically actuated mechanism designated to produce in definite succession and at predetermined intervals a continuity of impulse which may be utilized for signaling purposes. This apparatus is manufactured and sold by the Merchant Engineers' Corpora-



Automatic Timer for Firemen

tion, New York. The signaling is accomplished by the flashing of numbered lights or ringing gongs, or both, for the purpose of indicating the periods at which certain duties shall be performed.

The apparatus consists essentially of four parts, or units: First, a selecting switch of rotating lever type with external knob handle and indicator and internal roving bridge, through which connection is made across the different series of contact points; second, a frequency drum

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operated through a high to low reduction gear train by direct current motor; third, a sequence drum constantly maintained by a compound spring motor in a condition of carefully calculated torque, this in turn being regulated and controlled by an escapement lever operated by solenoid energized by intermittent impulse from the frequency drum; fourth, the field indicators, consisting of lamp signals, gongs, semaphores or other electrically actuated mechanical apparatus arranged singly or in groups, as may be required.

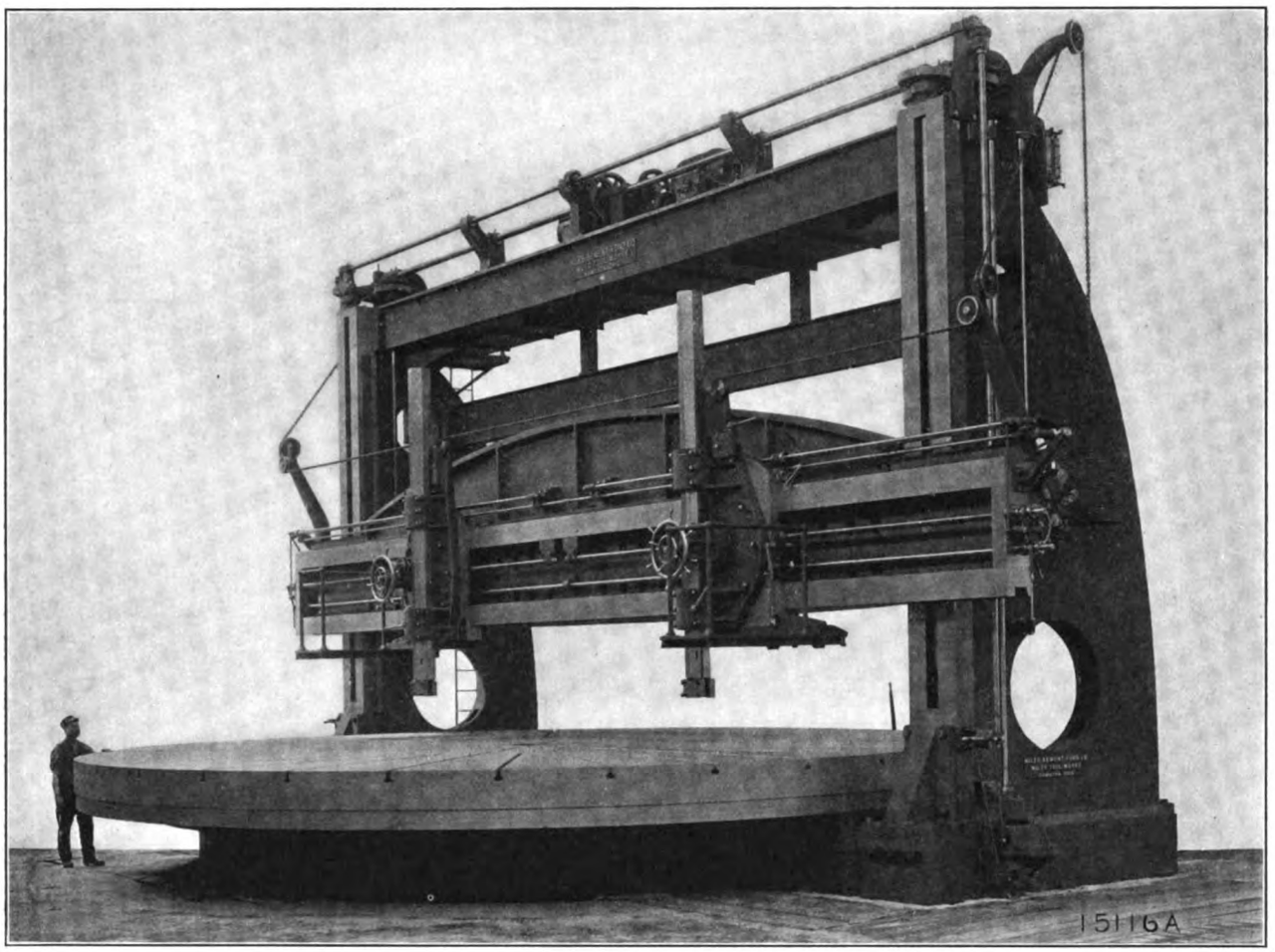
When used as a signaling device, as, for instance, in directing the operation of a boiler plant, having determined by test or otherwise the frequency with which the furnace should be fired in order to produce the requisite amount of steam, the engineer can indicate his requirements by setting the index of the "selecting switch" at the point corresponding to such frequency, the apparatus automatically producing the proper signals at a nearby or distant point.

On the dial plate of the "selecting switch" of this timer there is a series of numbered registrations at which points the index may be set to secure the different indications, which vary in periodic frequency from forty-five seconds to ten minutes.

It may be noted also that this timer is fitted with a tally mechanism by means of which the engineer can easily determine the exact amount of coal or other commodity consumed or handled during a given period.

Largest Boring Mill in America Installed at the Brooklyn Navy Yard

At the Brooklyn Navy Yard there has recently been completed the installation of the largest boring mill that has ever been built in the United States. This machine was made by the Niles-Bement-Pond Company, at the Niles Works, Hamilton, Ohio. It swings 36 feet in diameter and has 12 feet under the tools. The great swing of this machine is required for finishing the tracks of the turrets carrying the 14- and 16-inch guns of the new battleships. The mill will also be used for boring cylinders and machining cases of the steam turbines for the war vessels.



Cross-Rail Boring Mill, with 36-Foot Swing, Recently Installed at the Brooklyn Navy Yard

The significant feature about the size of this mill is that it is not of the so-called "extension" type, but it is a regular cross-rail machine with an actual swing of 36 feet 2 inches with the housings in a fixed position. An idea of the size and massiveness can be gained from the fact that the total net weight, including motors, is 665,000 pounds or 300 tons.

The table is designed to carry a weight of over 200,000 pounds. The extreme size of the table, 34 feet diameter, made it necessary to cast it in three parts. The three sections of table weighed 225,000 pounds. The table is supported on conical rollers running in a circular track 24 feet in diameter, sunk in the bed. The rollers are of high carbon steel and fitted to circular guide frames to insure alinement of the rollers. In addition, the table

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rests in an annular adjustable bearing ring surrounding the central spindle. The bearing ring is adjusted vertically by steel screws. The spindle is centered in the bed by an adjustable conical bush. The table tracks and spindle have forced lubrication from a pump operated from the main driving motor.

The table is fitted with a spur gear 28 feet in diameter which is a semi-steel casting, with teeth cut from the solid. It is driven by means of two forged steel pinions, placed on opposite sides of the mill.

The main part of the bed is made in two sections. There are two bed extensions attached to the main bed. The whole bed weighed 69,000 pounds in the rough, and the other section 48,600 pounds. The table tracks are rigidly supported by the vertical webs of the bed.

The housings are box castings connected at the top by a heavy cross brace. Rigidity is further increased by a steel girder connecting the housings. Each housing weighed in the rough 32,000 pounds.

The cross-rail is about 46 feet long and weighed 85,000 pounds in the rough. It is a box casting. Bolted to the top of the cross-rail is a camber beam designed to stiffen the cross-rail and take up the sag due to the great weight of the cross-rail and the heads. The combined depth of the cross-rail and the camber is 8 feet. The rail is raised and lowered by means of a 30 horsepower motor located on the top cross brace and connected to four elevating screws of large diameter working in bronze nuts.

The cross-rail is fitted with two heads for boring and turning. The heads are right and left, so arranged that either can be moved to the center. They are provided with graduating swivels, with worm gearing for setting them over to any angle on either side of the vertical of 30 degrees or less.

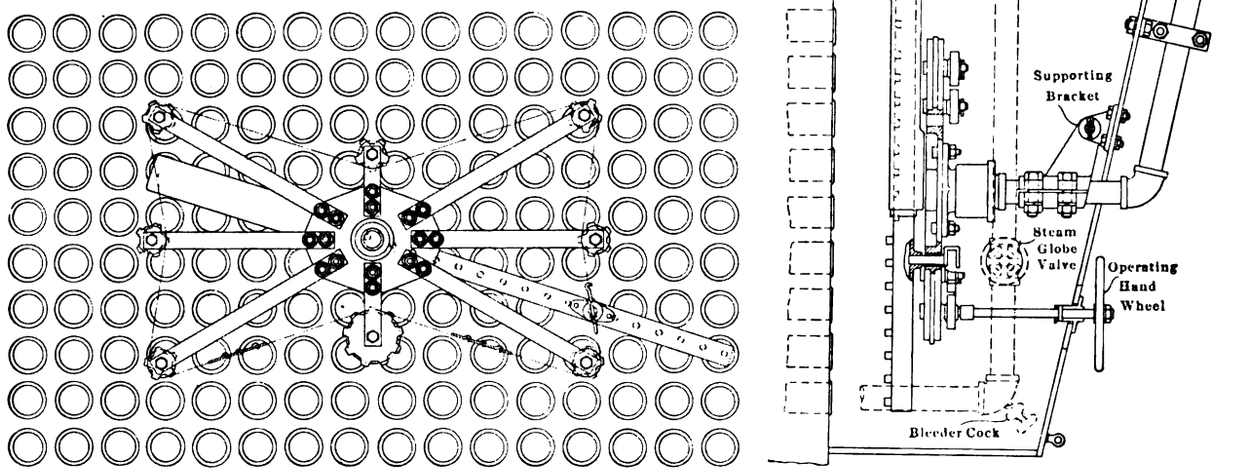
The heads and bars are provided with rapid power traverse, as well as hand movement for close adjustment. The rapid traverse is operated by a 10 horsepower motor located on the top brace. The control of these operations, and also the engaging and disengaging of feeds, is from a platform attached to each head, upon which the operator stands. The operating levers are interlocking, so that the rapid traverse cannot be engaged for one head unless it is disengaged from the other, making it impossible for the operator on one head to accidentally move the opposite one.

Eight reversible power feeds are provided for the bars and are operative in a vertical or angular direction. The feeds for each head are entirely independent and positive. Means are provided by friction clutches to prevent the breakage of feed gearing, should either bar or saddle encounter obstruction.

The main drive is by a 75 horsepower motor, and speeds are provided for boring, turning and facing operations.

The Planet Soot Blower

The Bennett-Dluge Company, Detroit, Mich., has placed on the market a device known as the Planet blower for cleaning the tubes of horizontal return tubular or Scotch boilers. The blower is a self-contained unit mounted with a bracket attachment on the uptake door. It is operated from outside by means of a hand wheel, and is supplied with steam, the steam valve and bleeder being within easy reach. The soot is blown from the front of the boiler to the rear. As shown in the illustration, there is a telescopic jet arm, which is caused to traverse the flue sheet area by means of a cam track which brings the jets directly in front of the tubes. The steam jets are at close range to the flue sheet, and, on account of the number of jets which are blowing directly into the tubes at the same time, a strong draft is set up, which insures a thorough cleaning of the tubes.



Planet Soot Blower Applied to a Scotch Boiler

Personal

W. S. Hardy has resigned as chief engineer of the tug *James H. Scott*, of Albany, N. Y.

Nicholas Snyder has resigned as chief engineer of the tug *Marguerite* of the Great Lakes Dock & Dredge Company.

Jacob Jones has resigned as chief engineer of the steamer *Trojan*, of the Hudson Navigation Company, New York.

John H. Ward, formerly chief engineer of the steamer *Old Colony*, of Fall River, Mass., has accepted a position on the steamer *Howard Co.*, of West Haven, Conn.

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Alexander Ryder, of New Haven, Conn., has accepted a position as chief engineer and electrician at the Hotel Garde, New Haven, Conn.

Edward O. Cutler, formerly assistant to the superintendent of construction at the Bath Iron Works, Bath, Me., is now assistant manager of the Craig Shipbuilding Company, Long Beach, Cal.

William Hurst has been appointed engineer of the tow boat *Eagan* of the West Kentucky Coal Company, Cairo, Ill. This boat is being sent South with a large tow of coal for Southern markets.

M. E. Farr, of Detroit, Mich., has been elected vice-president of the American Shipbuilding Company, Cleveland, Ohio, succeeding Mr. Edward Smith, who has been elected president of the company.

William Roach, of Buffalo, N. Y., is chief engineer of the giant dredge suction *Massachusetts,* in service on the Hudson River between Albany and Troy, N. Y. Captain Otto Erickson is in command of the dredge.

W. G. Eckert, first assistant engineer of the river steamer *Adirondack,* of the Hudson Navigation Company, New York, has been promoted to the position of chief engineer of the steamer *Trojan* of the same company.

Edward Elliott has been appointed assistant engineer of the transfer steamer *St. Genevieve,* which is owned by the Illinois Southern Railroad and used for transferring railway cars across the Mississippi River below St. Louis, Mo.

Peter Deitz has been appointed chief engineer of the tug *Yosephic.* This tug, which was formerly chartered by the United States Government, has been taken to Syracuse, N. Y., for State work. Captain Albert Hotaling has charge of the tug.

Rear Admiral Nathaniel Usher, formerly commandant of the Norfolk Navy Yard, Norfolk, Va., has been appointed commandant of the New York Navy Yard, Brooklyn, N. Y., succeeding Captain Albert Gleaves, who has been detailed to command the battleship *Utah.*

Jacob Holmes, of New York, is chief engineer of the steam yacht *Courier,* owned by Mr. Galt, of the flour firm of Galt & Company, of Washington, D. C. The yacht is now being prepared for an extensive voyage to South American ports with Mr. Galt and his family on board.

Jacob Reed, chief engineer of the steam yacht *Niagara,* owned by Howard Gould, of New York, and chartered several months ago by Joseph Leiter, of Washington, D. C., for a cruise around the world, reached Washington early in September on the return of the yacht to home ports.

Henry Stammell, formerly chief engineer of the steamer *Chester,* which was burned recently at New Hamburg, N. Y., has been appointed chief engineer of the tug *George E. Lattimer.*. George McCabe, captain of the *Chester,* has been transferred to the U. S. steamer *General Totten.*

George T. Cahill, formerly chief engineer of the tug *George E. Lattimer,* has accepted a position as chief engineer of the steamer *Marguerite,* owned by the Great Lakes Dock & Dredge Company. Captain George Trei, formerly in the U. S. Government service, is master of this steamer.

George Magee has been appointed chief engineer of the new ferryboat *Three States,* which has just been completed by the Howard Shipbuilding Company, Louisville, Ky., for service between Cairo, Ill., Birds Point, Mo., and Wickliffe, Ky. Mr. Magee has just left Cairo, Ill., for Louisville to bring out the new boat.

William Kersey is chief engineer of the steam yacht *Gaivoto,* owned by John R. Dos Passos, of New York. While coming up the Potomac River at night recently the propeller of the yacht struck an obstacle and the propeller shaft was broken. The yacht has been towed to Alexandria, Va., where she will be hauled out on a marine railway and repaired.

Victor Matte has been appointed chief engineer of the tug *George W. van Tuyl,* of Albany, N. Y., which was placed in service for the first time this season on August 31. The *George W. van Tuyl* is taking the place of the tug *James H. Scott,* which has been taken to Rondout, N. Y., for repairs to her boiler. Captain William McCann is master of the *George W. van Tuyl.*

Patrick O'Neil, connected with the bolt and rivet department of the Union Iron Works, of San Francisco, Cal., has completed his fiftieth year of continuous service with this company. In recognition of this anniversary John A. McGregor, president of the company, sent Mr. O'Neil a letter of thanks for his faithfulness and loyalty, inclosing a check for $1,000 (£205).

R. Earle Anderson, formerly engineer with the Lake Torpedo Boat Company, Bridgeport, Conn., has been appointed general manager of the Augusta-Savannah Navigation Company, Augusta, Ga., in charge of the Augusta Barge Line. Mr. Anderson was formerly connected with the Bureau of Construction and Repair, Navy Department, Washington, D. C., and is well known as a contributor to this journal.

Edward Smith, of Buffalo, N. Y., formerly vice-president of the American Shipbuilding Company, Cleveland, Ohio, has been elected president of the company, succeeding Mr. James C. Wallace, whose resignation was accepted by the board of directors September 23. Mr. Smith was also president of the Great Lakes Towing Company, but has severed his connection with this company to take up the duties of president of the shipbuilding company.

Jeff Burnell has been appointed chief engineer of the steamer *Angler,* which has been in operation on the River View excursion route from Washington, D. C., on the Potomac River during the summer. The *Angler* has now been chartered by the Chesapeake & Potomac Steamboat Company to take the place of the steamer *Wakefield* on the river route while the *Wakefield* is at Newport News for extensive repairs to her hull and machinery. The *Angler* is commanded by Captain Bailey Reed.

Captain I. N. Hibberd, for many years superintendent of the Pacific Coast Steamship Company, has resigned to become general manager of the shipping firm of Sudden & Christenson, San Francisco, Cal. Captain Hibberd will give his attention especially to the coast-to-coast service which has been inaugurated by this firm. This service will be carried on at present by five steamers of from 5,000 to 6,000 tons carrying capacity—the *Peter H. Crowell, J. A. Hooper, Louis K. Thurlow, Montroso* and *Neches,* all practically new vessels. The *J. A. Hooper* left San Francisco September 15 with a cargo of lumber and barley for the Atlantic coast. With the fleet actively in service the company will dispatch a vessel from departure points every three weeks.

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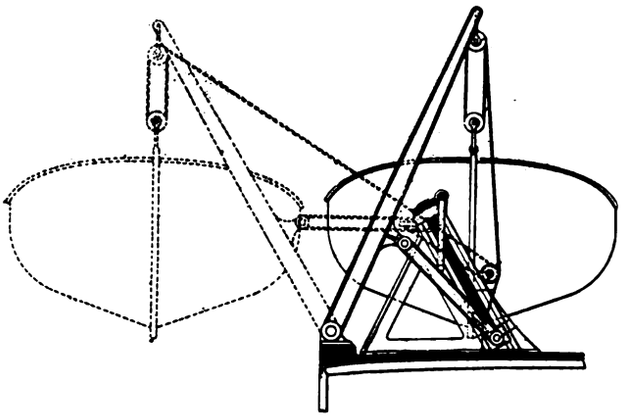
SELECTED MARINE PATENTS

The publication in this column of a patent specification does not necessarily imply editorial commendation.

American patents compiled by Delbert H. Decker, Esq., registered patent attorney, Millerton, N. Y.

1,105,594. DAVIT FOR LOWERING AND RAISING SHIPS' BOATS. ANDREAS P. LUNDIN AND HARRY W. BROADY, OF BAYSIDE, N. Y.; SAID BROADY ASSIGNOR TO SAID LUNDIN.

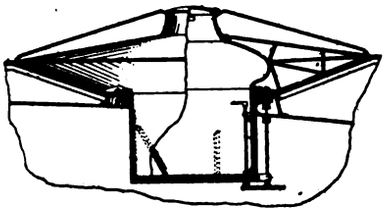
Claim 1.—The combination with a davit arm pivoted at its lower end to swing freely in a vertical plane to both sides of a perpendicular position, of a frame secured to the deck of a vessel, a screw supported in



said frame in an inclined position to have rotary movement only, a nut threaded on the screw, a link connecting said nut and davit arm and means for rotating the screw. Three claims.

1,103,958. SUBMARINE BOAT. ANTHONY J. GRIFFIN, OF NEW YORK, N. Y.

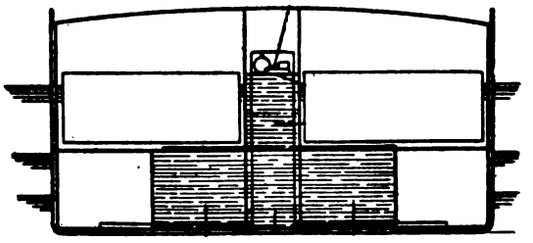
Claim 1.—In combination, a submarine boat having an outer shell and a deck above the outer shell, the deck having an opening therein, and the shell having a well therein located within the margin of the deck opening; a safety chamber for containing occupants of the boat, the



safety chamber having a lower portion entering the well and having an enlarged upper part flaring outward within the deck opening with the outer margin of the chamber substantially flush with the adjacent portions of the deck of the boat; means for releasably securing the safety chamber in place on the boat, and means for releasing the securing means. Twelve claims.

1,107,741. UNIT-CARGO VESSEL. FREDERICK A. BALLIN AND EDWARD H. DODGE, OF PORTLAND, ORE.

Claim 1.—In a vessel provided with an opening hull portion at one end for floating in loaded barges, an upper deck, a load-carrying deck below the upper deck, longitudinal bulkheads inclosing a central submerging compartment above and below the load carrying deck, extending

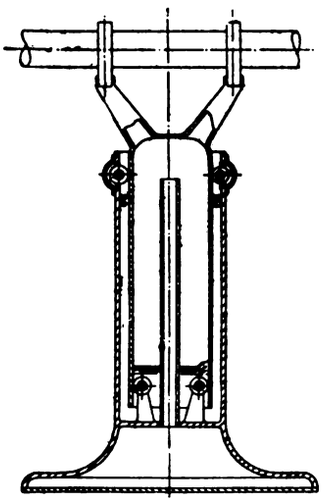


lengthwise of the vessel, the space below the load carrying deck being so divided as to provide reserve buoyancy compartments at the sides of the vessel, supplementary submerging compartments located between such reserve buoyancy compartments and the central submerging compartment, said reserve buoyancy compartments so proportioned that their combined displacement equals the weight of the vessel, said submerging compartments so proportioned that when flooded they will sink the vessel to its loading draft, and when emptied their combined displacement in supplement to that of said reserve buoyancy compartments will place the vessel, with full load, in the condition of its normal draft, and means for flooding said submerging compartments. Twelve claims.

British patents compiled by G. F. Redfern & Company, chartered patent agents and engineers, 15 South street, Finsbury, E. C., and 10 Gray's Inn Place, W. C., London.

5405/1914. MOUNTINGS FOR INSTRUMENTS ON BOARD SHIP. PROF. A. BARR, OF THE UNIVERSITY OF GLASGOW AND W. STROUD.

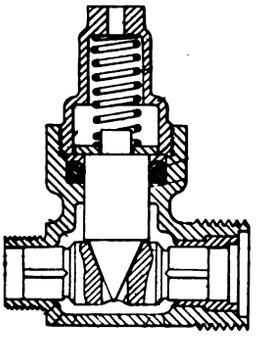
Claim.—A mounting, for supporting instruments on board ship by means of a volume of air maintained under pressure by the weight of the load acting upon the air in opposition to a head of liquid, is characterized by the volume of air being great in comparison with the change of volume due to any probable vertical displacement of the mounting caused by vibrations. The mounting consists of a tank containing liquid, a reservoir having a communication near the head of the tank, an inverted vessel placed within the tank upon which the instrument is carried, the inverted vessel and connected parts being sup-



ported by air contained within the vessel, and the reservoir maintained under pressure by the weight of the load acting in opposition to the head of liquid contained in the tank.

15,398/1913. IMPROVEMENTS IN VALVES FOR HYDRAULIC SYSTEMS, ESPECIALLY SUCH SYSTEMS AS ARE APPLICABLE FOR OPERATING BULKHEAD DOORS AND THE LIKE. J. STONE & CO., LTD., DEPTFORD, F. J. PIKE AND H. NEVILLE, ALL IN THE COUNTY OF KENT.

Relates to improvements in valves for hydraulic systems for operating bulkhead doors and to an improved means for automatically putting the ram of the hydraulic cylinder or cylinders operating each door in equilibrium upon the cessation or failure of hydraulic pressure in the mains so that the door or device may be capable of manual operation with per-



fect freedom. It consists of a casing having two oppositely situated openings leading therefrom which are placed in communication one with each end of the cylinder in the case of a system employing a double-acting cylinder. Within the chamber is placed a double-acting valve with valve faces formed on the ends and supported in axial alignment with annular seatings. In order to hold the valve in a midway position upon the failure of pressure in the system there is provided a plunger which is projected into the valve holding same in midway position by the action of the spring, as clearly shown in the drawing. Modifications are described.

6,380/1913. IMPROVEMENTS IN DAVITS. THE MARTIN PATENT DAVIT CO., LTD., of 9 UNION COURT, LIVERPOOL, AND E. S. GLADSTONE.

The invention consists in making the upper guiding track and the lower guiding track rectilinear, and in arranging the two tracks at such an angle that the davit as it moves along them receives the required tilt. The transverse shaft which connects the two davits of a pair is placed as low down on the davits as possible and carries pinions engaging holes in the under surface of the lower track, while a plain wheel on the davit runs on the upper surface of the upper track. The lower track is inclined upwardly from inboard to outboard, while the upper track is inclined downwardly. With such an arrangement the head of the davit can be caused to descend slightly as the davit moves out through the lower end rises slightly, with the result that both outboard and inboard movements are effected very easily.

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